Health Start Program Evaluation Impact Report

2006–2016

Arizona Department of Health Services

ARIZONA DEPARTMENT OF HEALTH SERVICES

NAU NORTHERN ARIZONA UNIVERSITY
Center for Health Equity Research

THE UNIVERSITY OF ARIZONA

ARIZONA HEALTH START PROGRAM

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Dedication

Thank you to the hundreds of Health Start Program CHWs who have worked tirelessly to improve maternal and child health equity for thousands of mothers, infants, and children across Arizona.

Suggested citation

McCue K, Sabo S, Wightman P, Jimenez D, Rumann S. Health Start Program Evaluation, 2006-206: Final Impact Report. Phoenix, AZ: Arizona Department of Health Services; 2021.

Related Publications

Sabo S, Butler M, McCue K, et al. Evaluation protocol to assess maternal and child health outcomes using administrative data: A community health worker home visiting programme. *BMJ Open* 2019;**9**:e031780. doi:10.1136/ bmjopen-2019-031780

Sabo S, Wightman P, McCue K, et al. Addressing maternal and child health equity through a community health worker home visiting intervention to reduce low birth weight: Retrospective quasi-experimental study of the Arizona Health Start Programme. *BMJ Open* 2021;**11:**e045014. doi: 10.1136/bmjopen-2020-045014

Executive Summary

The purpose of this evaluation is to assess the impact of the Health Start Program, Arizona's longstanding community health worker (CHW) intervention, on maternal and child health (MCH) outcomes. The Health Start Program serves 'high risk' women who are pregnant or have a child under age two. This retrospective observational study utilizes Arizona Department of Health Services (ADHS) administrative data and a propensity score matching study design.

This study found that participation in Arizona's Health Start Program during 2006 to 2016 improved low birthweight and preterm birth outcomes, prenatal care attendance, and on-time child immunizations.

The intention of this evaluation is to align with US Department of Health and Human Services' criteria for Home Visiting Evidence of Effectiveness (HomVEE) models, and the national Maternal, Infant, and Early Childhood Home Visiting (MIECHV) health domains. Analyses include the following subgroups: Hispanic/Latina, American Indian, rural border communities, less than a high school education, teen and first-time mothers, and women with pre-pregnancy health risks (e.g. diabetes, hypertension). Many of these subgroups are historically underserved by programs supporting maternal and child health promotion, and often less likely to engage in prenatal care, more likely to have low birthweight and/or preterm births, and less likely to adhere to recommended child immunization schedules.

Results of the Study

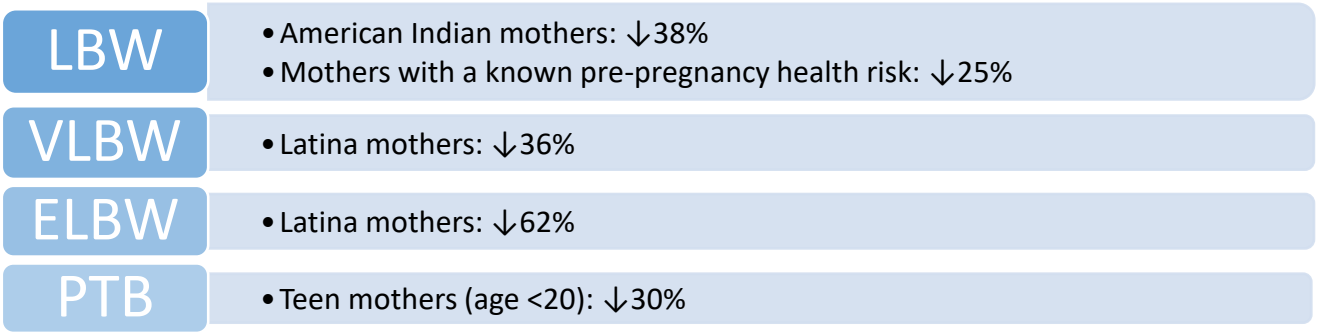
Low Birthweight & Preterm Births

Low birthweight (LBW) is birthweight less than 2500g despite gestational age. The most common causes of LBW are preterm birth (PTB; less than 37 completed weeks of pregnancy) and fetal growth restriction. LBW is further categorized as very low birthweight (VLBW; less than 1500g) and extremely low birthweight (ELBW; less than 1000g). LBW is associated with several interlocking socioecological risk factors, including poverty, discrimination, and access and quality of care, among others.[2] Rates of LBW, VLBW, and ELBW in the US consistently track with socioeconomic and ethno-racial health inequities.[3] Women of color, specifically African American, Latina, and American Indian, experience disproportionally higher rates of LBW and PTB birth outcomes.[4,5]

Key Findings

Participation in the Health Start Program during 2006 to 2016 is associated with statistically significant decreases in adverse birth outcomes for most subgroups, compared to their matched controls (Figure 1). [n=7,212 (HSP group); n=53,948 (unweighted non-HSP matched control group). Full results: p. 17; Tables 6a-6b]

Figure 1. Summary of results: Mothers in the Health Start Program had lower rates of low birthweight & preterm births, relative to a matched comparison group.



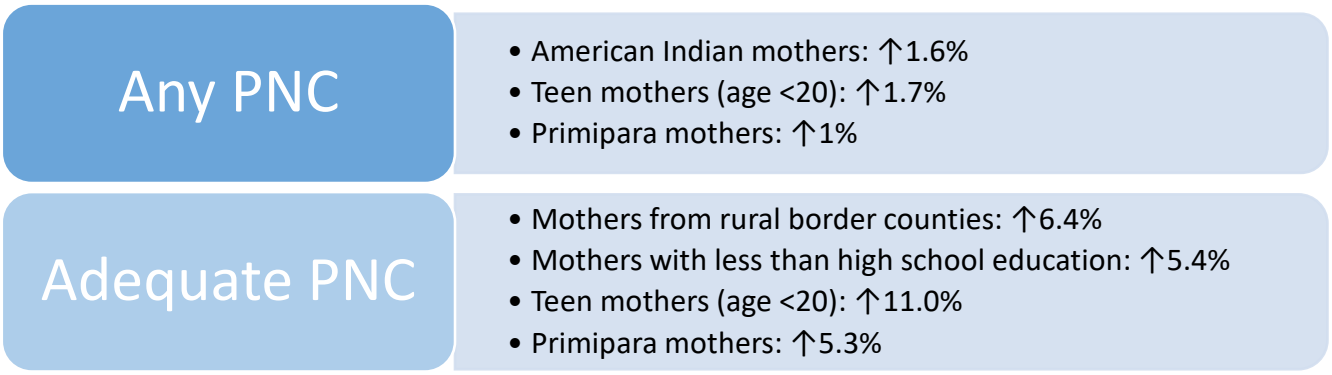
Prenatal Care

Prenatal care (PNC) visits with a healthcare provider usually include a physical exam, weight checks, and urine, blood, or imaging tests depending on the trimester or needs of the pregnancy. Adequate prenatal care is widely accepted to help prevent pregnancy and birth-related complications and linked to improved pregnancy and birth outcomes.[6] The American College of Obstetrics and Gynecologists (ACOG) recommends one PNC visit per month through 28 weeks, two visits per month through 36 weeks, and weekly visits thereafter. Adequate PNC is measured as initiating PNC during the first four months of pregnancy, plus the ratio of received to recommended PNC visits greater or equal to 0.8.[7] As an early intervention, PNC has the subsequent potential to reduce the cost burden to families and health systems[8] and impact the life course health of women and their families over generations.

Key Findings

Participation in the Health Start Program during 2006 to 2016 is associated with statistically significant increases in prenatal care attendance for most subgroups, compared to their matched controls (Figure 2).
[n= 7,117 (HSP group); n= 53,213 (unweighted non-HSP matched control group). Full results: p. 18; Table 8]

Figure 2. Summary of results: Mothers in the Health Start Program had higher rates of any & adequate prenatal care, relative to a matched comparison group.



Child Immunization

Per the Centers for Disease Control and Prevention (CDC), Advisory Committee on Immunization Practices (ACIP), the American Academy of Pediatrics, and the American Academy of Family Physicians, vaccines are cited as an effective measure to prevent several diseases. Vaccines introduce a small amount of antigen to reduce risks of infection and boost immune responses. While many babies are born with an immune system ready to stave off some germs, their immune systems are not able to protect against a number of common deadly diseases.[9] Table 1 lists seven (7) vaccinations recommended for children under age 2, per CDC guidelines[10], that are assessed by this study. Timely completion of vaccinations for children are considered a cost-effective intervention and associated with improved quality of life and overall cost savings.[11]

Table 1. Seven CDC-recommended vaccinations for children age ≤2.

1. Diphtheria/tetanus /pertussis (DTaP/DTP)
2. *Haemophilus influenzae* type b (Hib)
3. Hepatitis B (HepB)
4. Measles-mumps-rubella (MMR)
5. Pneumococcal conjugate vaccine (PCV13)
6. Poliovirus
7. Varicella

Key Findings

Participation in the Health Start Program during 2006 to 2016 is associated with statistically significantly higher immunization rates across *all* subgroups, compared to their matched controls (Figure 3).
[n= 7,218 (HSP group); n= 54,175 (unweighted non-HSP matched control group). Full results: p. 19; Table 10]

Figure 3. Summary of results: Children in the Health Start Program have higher rates of completing recommended childhood immunizations, relative to a matched comparison group.

≥5 vaccines

- American Indian children: ↑4.8%
- Latino children: ↑5.0%
- Children living in rural border counties: ↑4.9%
- Children of teen (age <20) mothers: ↑5.9%
- Firstborn children: ↑3.8%
- Children of mothers with a pre-pregnancy health risk: ↑5.5%
- Children of mothes with less than high school education: ↑6.1%

7 vaccines

- American Indian children: ↑5.7%
- Latino children: ↑6.2%
- Children living in rural border counties: ↑7.3%
- Children of teen (age <20) mothers: ↑6.0%
- Firstborn children: ↑5.1%
- Children of mothers with a pre-existing health risk: ↑8.5%
- Children of mothes with less than high school education: ↑6.5%

Recommendations

- Integrate CHWs as a cost-effective healthcare workforce in community-based and clinical settings
- Support CHWs as primary interventionist, to work with Latina, American Indian, rural-residing, and teen mothers to improve birthweight, prenatal care utilization, and child immunization uptake
- Provide CHWs with additional resources and training to support their capacity to connect with each client more frequently during pregnancy, including before and after each PNC appointment
- Develop and expand transportation assistance to all Health Start Program sites to address a potential barrier to utilizing perinatal care services (e.g. prenatal care visits, child immunization appointments)
- Strengthen education topics covered by CHWs (e.g. healthy weight, pre-existing health conditions)

Implications

Several public health entities conclude that CHW-centered interventions have a positive impact in health promotion and disease prevention, in community and clinical settings. This study provides much needed evidence to guide policymakers and practitioners on integration of CHW perinatal home visitation.

The Arizona Health Start Program and its 25-year commitment to strengthening maternal and child health is a healthcare innovation that can improve birthweight and preterm birth, prenatal care attendance, and child immunization rates among ethno-racially, socioeconomically, and geographically diverse mothers and infants in Arizona. Results from this study depict the dedication of Health Start *promotoras* and CHWs to improving maternal and child health across the state.

ARIZONA HEALTH START PROGRAM

Full Impact Report

Description of the Health Start Program

The first iteration of the Arizona Health Start Program was called "*Un Comienzo Sano*/A Healthy Beginning," which was administered by the Rural Health Office of the University of Arizona College of Medicine, Department of Family and Community Medicine from 1984 to 1992, to address the steady increase in the rate of women receiving inadequate or no prenatal care. At that time, Arizona was ranked 45th lowest in the nation for the number of women receiving adequate prenatal care.[1] Leadership shifted to the Arizona Department of Health Services (ADHS), Bureau of Women's and Children's Health (BWCH). In 1994, the Arizona State Legislature passed the Arizona Children and Families Stability Act, A.R.S. § 36-697, formalizing and expanding the purpose, requirements, and administration of the Health Start Program. Originally funded through state general funds, and later the Tobacco Litigation Settlement Fund, the Health Start Program has been funded by the Healthy Arizona Initiative lottery funds since 2004 with allocations of approximately $2.5 million annually.

The Health Start Program is currently offered in 14 communities across the state of Arizona to better address the socio-behavioral healthcare needs that many high-risk pregnant women and their families may experience. Figure 4 highlights the sites and zip codes served by the program. A complete list of site contacts is in the Appendix, Table 12.

Mission Statement:
"To educate, support and advocate for families at risk by promoting optimal use of community-based family health care services and education services through the use of community health workers (CHWs) who live in and reflect the ethnic, cultural and socioeconomic characteristics of the community they serve."

Goals: 1) Increase prenatal services to pregnant women; 2) Reduce the incidence of very low birthweight babies; 3) Reduce the incidence of children affected by childhood diseases; 4) Increase the number of children receiving age appropriate immunizations by age two; 5) Increase awareness by educating families on the importance of good nutritional habits, developmental assessments, and preventative health care.[1]

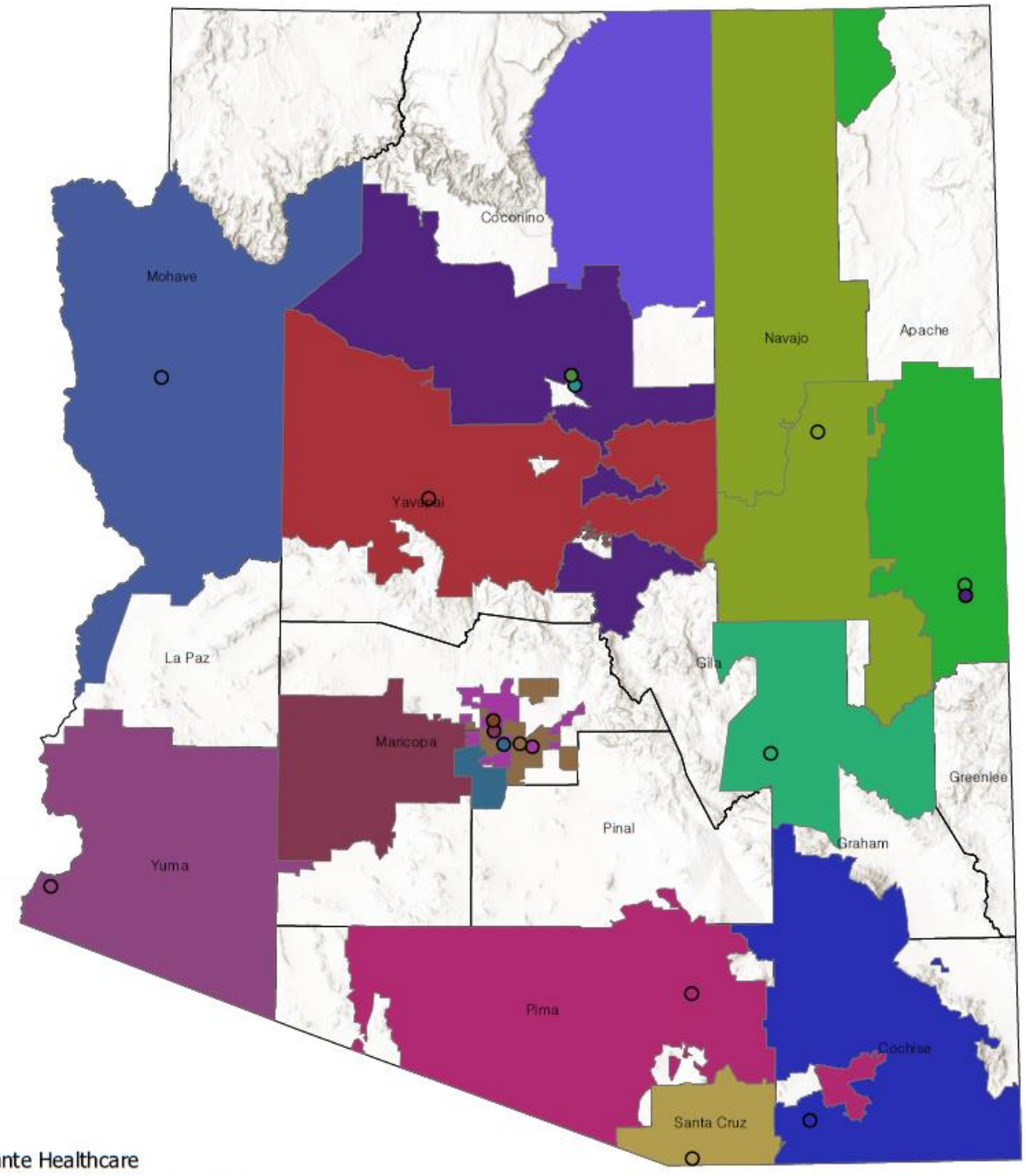
Eligibility criteria: Women who 1) live in the targeted service area, 2) are pregnant or postpartum with a child under age two, and 3) have one or more risk factors. Women and families can be of any age and there are no income requirements.

The Health Start Program is a community-based outreach program that identifies, screens, and enrolls pregnant women early in their pregnancies; assists them with obtaining early and consistent prenatal care; provides prenatal and postpartum education, information, referral services, and advocacy; and emphasizes timely immunizations and developmental assessments for their children (Table 2). CHWs serve as the primary interventionists and home visitors for the Health Start Program. CHWs are recognized as integral contributors in collaborative health and community-based teams and in providing comprehensive care, including attention to the social determinants of health, which contribute to health improvements and cost savings.[12-14]

Table 2. Health Start Program community health worker (CHW) activities.

- Identify pregnant/postpartum women in the CHW's service area, and enroll them into HSP
- Conduct monthly prenatal/postpartum home visits and case management through enrolled child's 2nd birthday
- Connect client to prenatal care providers and on-going education and social support related to fetal development and health behaviors that may impact birth outcomes
- Screen for postpartum depression and provide information regarding inter-conception health
- Assess for various medical and social risks; offer education, goal planning, referral, and advocacy services
- Educate clients about child development, immunizations, home safety, and vehicle safety
- Assist clients with access to various health-promoting opportunities including a medical home, early childhood education programs, financial assistance, transportation, employment services, and referral services

Figure 4. Arizona Health Start Program service area map, 2021.



- Adelante Healthcare
- Apache County Health Department
- Cochise County Health & Social Services
- Coconino County Public Health Services District
- Mariposa Community Health Center
- Mohave County Health Department
- Native Health Community Health Center (Mesa)
- Native Health Community Health Center (Phoenix)
- North Country Healthcare, Inc (Apache County)
- North Country Healthcare, Inc (Flagstaff)
- North Country Healthcare, Inc (Navajo County)
- Pima County Health Department
- San Carlos Apache Tribe
- Tempe Community Action Agency
- Unlimited Potential
- Yavapai County Community Health Services
- Yuma County Health Department

Health Start Program CHW Training

According to the Health Start Program policy and procedure manual, CHWs must 1) live and work in the service area, 2) reflect the ethnic, cultural, and socioeconomic characteristics of the communities they serve, 3) be able to read and write English, 4) have a high school diploma or General Educational Development (GED), and 5) have a background check. It is highly recommended that CHWs have post high school training in maternal and child health, early childhood development education, family studies, social work, nursing, or a closely related field.[1]

Before they can provide services unsupervised, CHWs must complete 8 hours of home visit shadowing plus 40 hours of Health Start Core Training[1] (Table 3) and CHW Core Competencies training (set forth by the CHW Core Consensus Project;[15] recognized by the Arizona state legislature HB 2324 Voluntary CHW Certification[16]). Competencies include: cultural and systems mediation, social support, advocacy, capacity building, care coordination, systems navigation, community outreach, and assessment.[17] Additionally, CHW's must complete 16 hours of training on the research based Partner's for a Healthy Baby curriculum and 16 hours of continuing education per year. Full-time CHWs build their caseload to reach a total of 40 active clients, of which a majority must be prenatal.

Table 3. Health Start Program Core Training topics.

Foundational: outreach, home visits, support, communication
Pregnancy: prenatal care, nutrition, physical activity, labor and delivery
Postpartum: nutrition, physical activity, postpartum care, family planning
Child: infant and child health, immunizations, early childhood development, parenting skills
Safety: home safety for infants and children, child abuse, domestic violence

Program Theory of Change & Evaluation Framework

CHWs are trusted members of their communities and understand the lived experiences and cultural knowledge of the population. They are well positioned as supportive role models and guides for their clients, increasing clients' continuity of care during and after pregnancy.[18-20] The CHWs are trained to motivate and support their clients through behavior change activities that promote personal agency and self-efficacy and achieve program goals. The Health Start Program is guided by two behavioral change theories, the Trans Theoretical Model of Behavior Change (TTM) and Social Cognitive Theory (SCT).[21,22] These theories assume, respectively, that behavior modification in individuals is a multistage process in which people move through stages of readiness for change, and that they do so in the context of reciprocal relationships with their environment, behavior, and cognition. TTM and SCT guide each home visit, and are supplemented by adult learning models to acknowledge the agency of adult learners, integrate new information, and create a cognitive structure that makes sense of their surroundings and situations.[23]

Health Start Program CHWs encourage critical thinking about empowerment and personal agency. Although not an exhaustive list, Figure 5 outlines activities conducted by the CHWs. Home visiting sessions aim to overcome the barriers to personal agency and behavior change through assessment, education, goal setting, and support.

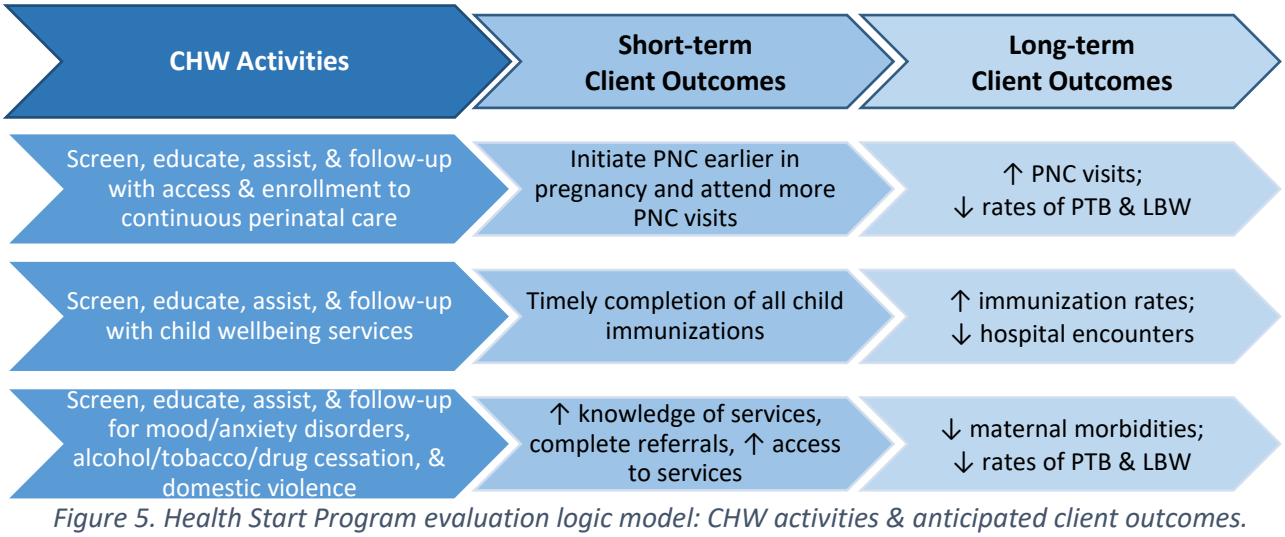


Figure 5. Health Start Program evaluation logic model: CHW activities & anticipated client outcomes.

Summary of Prior Health Start Program Evaluation

A previous evaluation of the Health Start Program was conducted by Hussaini et al. (2011), which found that Health Start Program participation was associated with a reduction in the likelihood of a low birthweight outcome.[24] The current evaluation builds upon the Hussaini study in four key ways:

1. **Time period:** The Hussaini study evaluated health outcomes of women who participated in the Health Start Program in 2007 (1 year).
   - The current study evaluated health outcomes of women who participated in the Health Start Program between 2006 to 2016 (11 years).
2. **Population:** The Hussaini study compared 484 Health Start Program participants to a control group of almost 5,000 women.
   - The current study compared over 7,200 Health Start Program participants to a control group of over 53,000 women, and included demographic subgroup analyses.
3. **Baseline equivalence:** The Hussaini study used non-participant mothers with at least one medical risk (as reported on their birth certificate) as their comparison cohort. While this uni-dimensional matching approach narrowed differences (on average) between groups, disparities remained. For example, the control group was on average four years older (28.2 vs. 24.3) than Health Start Program mothers. Additionally, identifying and defining the control group on ex post medical risks likely created a bias in favor of finding a positive program effect.
   - The current study used propensity score matching (PSM) to generate a control group, utilizing a number of maternal characteristics to identify "matches". These include demographic, geographic, and socioeconomic status (SES) variables. The SES variables are indicators for maternal education, primary payer for the birth procedure (including self-pay), as well as neighborhood income levels (obtained from the American Community Survey). All characteristics are measured prior to the mother giving birth. Matching is complete only once baseline equivalence (i.e. statistical similarity across all variables between the treatment and control group) is achieved. These protocols align with the Home Visiting Evidence of Effectiveness (HomVEE) "moderate" study rating. Upon review, meeting this criteria will certify the program as "evidence-based".[25] HomVEE reviews early childhood home visiting models that serve families with pregnant women and children from birth to five, to assess the quality of the research and determine if the model is evidence-based. (As a retrospective study based on secondary data, "moderate" is the highest rating for which this evaluation is eligible.)
4. **Outcomes:** The Hussaini study examined the Health Start Program effect on low birthweight.
   - The current study examined the Health Start Program effect on low birthweight, preterm birth, prenatal care, and child immunizations.

Evaluation Aims

This quasi-experimental retrospective design is based on 11 years of observational data from 2006 to 2016, and compares Health Start Program participant outcomes to probabilistically-matched synthetic comparison groups. The following aims guided the evaluation of the Health Start Program (Table 4). An evaluation timeline is listed in the Appendix, Table 11.

Table 4. Health Start Program evaluation aims and measurable outcomes.

Evaluation Aims	Measurable Outcomes
Aim 1: Impact of the Health Start Program on newborn health	• Birthweight (low birthweight <2500 grams, very low birthweight <1500 grams, extremely low birthweight <1000 grams) • Preterm birth (<37 weeks gestation)
Aim 2: Impact of the Health Start Program on maternal health and care utilization	• Receipt of any prenatal care • Overall adequacy of prenatal care
Aim 3: Impact of the Health Start Program on child health	• Adherence to CDC-recommended immunization schedules

Population of Interest

Arizona State Context

Arizona is a large, demographically and geographically diverse state, sharing an international border with Mexico and home to 22 federally recognized American Indian Tribes and Nations (Figure 6).[26] It is the 6th largest US state in size, but 16th by population, with large uninhabited and rural areas.

The 2016 Census for Arizona was 6.8 million residents. Compared to the US, Arizona has a higher proportion of Latino (31%) and American Indian (4.5%) residents (US: 18% and 1%, respectively) and a comparatively smaller proportion of African American (5%) and Asian/Pacific Islander (3.5%) (US: 13% and 6%, respectively) (Figure 7).[27,28] Nearly a quarter of the population lives in rural areas, where the poverty rate is almost double that of the nation.[29]

Figure 6. Map of federally recognized tribes in Arizona.

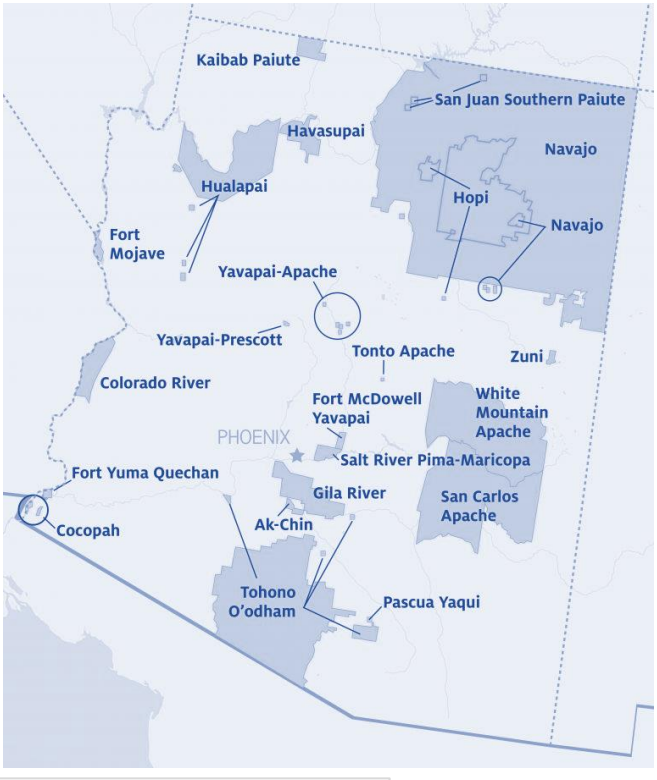
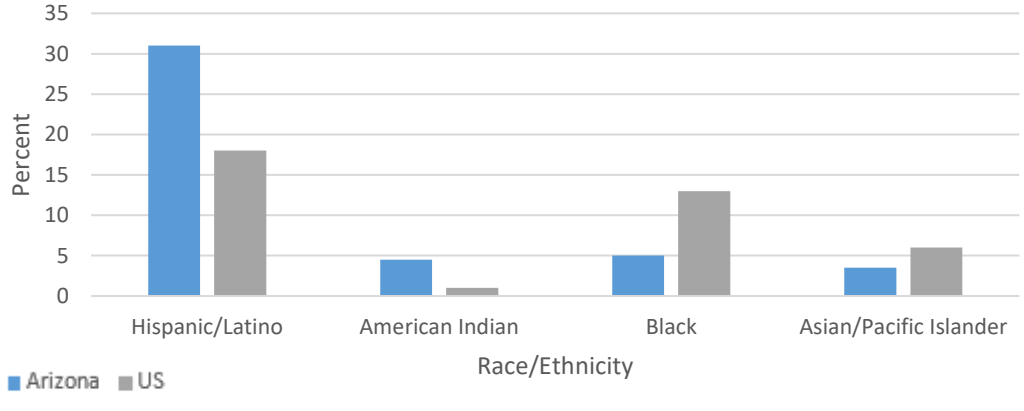


Figure 7. Proportion of Arizona & US populations by race & ethnicity, excluding white non-Hispanic, 2016.



Mothers and children of color in Arizona experience disparate health outcomes. Of particular focus of this evaluation, there are racial and ethnic health disparities for birth outcomes, prenatal care utilization, and child immunization uptake. For example, Latina and American Indian mothers have higher rates of very low birthweight (VLBW), extremely low birthweight (ELBW), and preterm birth (PTB) births compared to the state. American Indian mothers also have higher rates of low birthweight (LBW) compared to Arizona state rates[28] (Figure 8). The rates of any prenatal care (PNC) among American Indian and Latina mothers are similar to the state rate. The rates of adequate PNC utilization among American Indian (54.65%) and Latina (65.28%) mothers are lower than the state rate (71.28%)[28] (Figure 9). Additionally, per a report on immunization compliance rates among children (age 2) enrolled in Arizona Medicaid,[30] American Indian children have lower rates of completion for *diphtheria, tetanus and acellular* (DTaP) and *haemophilus influenza type b* (Hib), which require more than one dose. Latino children consistently have higher completed immunization rates by age 2 across all vaccine types compared to the state (Figure 10).

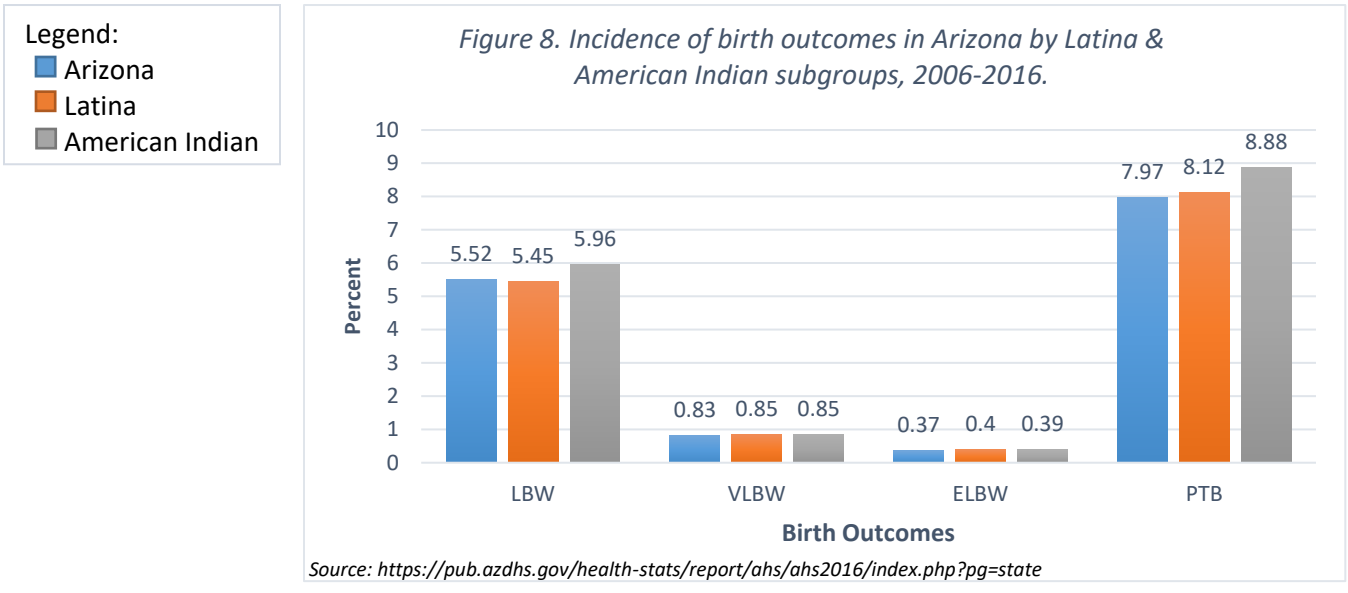


Figure 8. Incidence of birth outcomes in Arizona by Latina & American Indian subgroups, 2006-2016.

Source: https://pub.azdhs.gov/health-stats/report/ahs/ahs2016/index.php?pg=state

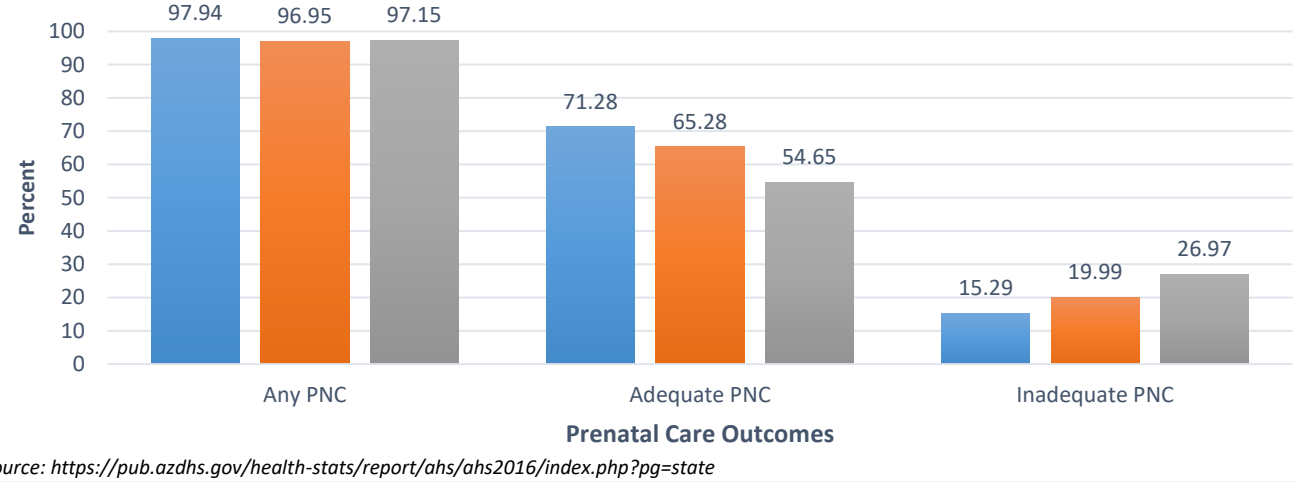


Figure 9. Incidence of prenatal care outcomes in Arizona by Latina & American Indian subgroups, 2006-2016

Source: https://pub.azdhs.gov/health-stats/report/ahs/ahs2016/index.php?pg=state

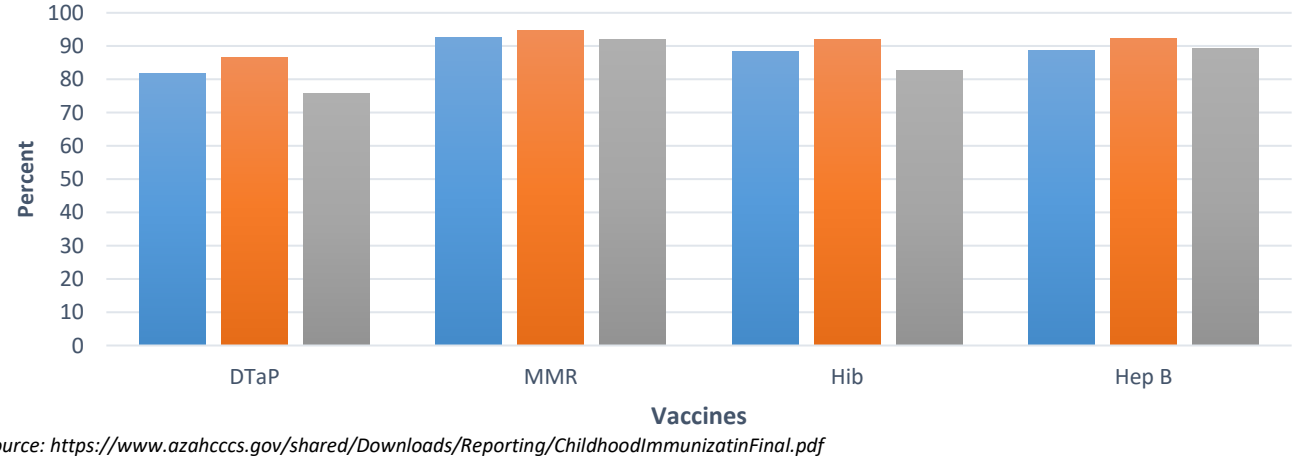


Figure 10. Completion rate of immunizations among children aged 2 years enrolled in AHCCCS, by Latina & American Indian subgroups, 2016

Source: https://www.azahcccs.gov/shared/Downloads/Reporting/ChildhoodImmunizatinFinal.pdf

Health Start Program Population

Women who participated in Health Start Program during the 11-year observation period self-selected the 'intervention.' Per the Health Start Program manual, women are eligible to enroll in the program if they 1) live in the targeted service area, 2) are pregnant or postpartum with a child under age two, and 3) have one or more risk factors.[1] Women and families can be of any age and there are no income requirements. All enrolled clients during 2006 to 2016 were included in this study if their records were identified and linked from the Health Start Program database to vital records birth data (VRBD). A comparison group of women not exposed to the Health Start Program (non-HSP) was created using a matching technique to enhance equal representation of subjects in each group. Non-HSP information was derived from the VRBD.

Risk factors are divided into 2 categories:
Social risks: marital status, living situation, race/ethnicity, education level, income, insurance type
Medical risks: previous preterm birth/labor and low birthweight, miscarriage, birth defects, chronic diseases, maternal weight/height/age

Sample Size

17,327 unique mothers were enrolled in the Health Start Program from 2006 to 2016. These program records were linked to birth certificate records in the VRBD. Data utilized in this study were limited to mothers enrolled during pregnancy, prior to giving birth, resulting in 7,212 records. A list of Health Start Program client demographic information is found in the Appendix, Table 13.

Study Design and Methodology

Data Sources

Outcome data for 2006-2016 were accessed from the ADHS administrative sources outlined in Table 5. Three datasets were accessed: the Health Start Program Data and Vital Records Birth Data (Aims 1-3), and the Arizona State Immunization Information System (ASIIS; Aim 3 only). Because this was a retrospective study, pertinent data were accessed at the beginning of the proposed evaluation study timeline in 2017. This study was approved by the University of Arizona's Institutional Review Board and the Arizona Department of Health Services Human Subjects Review Board.

An honest broker process was established to securely access and protect the original ADHS datasets. Using the available personally identifiable information (e.g., name, DOB, social security number) the Honest Broker linked the Health Start Program database to the VRBD and subsequently linked both the Health Start Program participants and their matched control groups to their ASIIS records. The Honest Broker then created a separate limited dataset (i.e. stripped of all identifiers) for analysis. This strategy was instrumental in procuring evaluation data and ensuring anonymity of all Health Start Program participants and their matched controls. This evaluation was designed to take full advantage of the depth of the Health Start Program and the breadth of the informational resources made available by ADHS.

Health Start Program administrative enrollment and program engagement data were curated to create a longitudinal panel of all Health Start Program enrollees. The Health Start Program enrollment data were queried against the VRBD using a combination of mother's first name, last name, and date of birth. To be counted as linked, the mother's first name had to be at least 95% similar, using Jaro-Winkler (JW) similarity,[31] and date of birth had to be an exact match. The final linked dataset included a distinct ID (internally generated unique identifier) for all mothers, and additionally for Health Start Program enrollees: first name similarity percentage, last name similarity percentage (for confirmation purposes only, given the frequency of maternal last name changes around pregnancy this was not used to establish links), and program enrollment date.

Table 5. Datasets accessed to evaluate specified outcomes and rationale for Health Start Program evaluation.

Dataset (Years)	Outcome Measures	Rationale
Health Start Program Data (2006-2016)	• Enrollment	All available data elements were accessed, including qualifying eligibility information (e.g. timing of enrollment, name, date of birth)
Vital Records Birth Data (VRBD) (2006-2016)	• Initiation of PNC • Number of PNC visits • Gestational age at delivery • Birthweights	Arizona used the 1989 version of the US Standard Certificate of Live Birth through 2013, which was updated in 2014. Both certificate versions were accessed for this study. Data were compared across the two versions, and only measures that were either collected consistently or could be made consistent from 2006-2016 were used.
Arizona State Immunization Information System (ASIIS) (2006-2015)	• Child immunization completion	These records include information on immunizations for children in Arizona. ASIIS reporting is mandatory for all children in Arizona as stated in ARS § 36-135 and AAC R9-6-706 & 707 (children aged ≤18 are required to obtain certain vaccines in order to access childcare facilities and schools; health care providers are required to report immunizations administered to children.) Vaccines were identified through CVX codes and descriptions. CPT Code information was used to distinguish between the 3- and 4-dose Hib vaccines. Dosage timing was measured by comparing the dates of administration and the date of birth. Adherence and completion was then measured by comparing age at administrations against the recommended schedules published annually by the CDC.[32]

Propensity Score Matching

Propensity score matching (PSM) was used to create control groups with the same observable baseline characteristics as the Health Start Program intervention groups. Conceptually, PSM identifies counterfactual outcomes for participants (i.e. what would have happened in the absence of participation), as measured by the non-participant matched-control group. This estimated effect is often referred to as the average treatment-on-the-treated (ATT) effect, or the impact of the program among those who participated.

In order to generate an unbiased estimate of the treatment effect of the Health Start Program, the variables included in the matching model are selected based on their association with both treatment status (e.g. Health Start Program participation) and the outcomes of interest.[33] Because Health Start Program eligibility focuses largely on social and medical risks, the study prioritized inclusion of measures that meet these criteria, as well as characteristics that have been shown to have strong associations with the outcomes of interest in previous empirical and theoretical work. In order to achieve a "moderate" rating described earlier, HomVEE requires at least two direct measures of SES.

The final evaluation is based on nearest-neighbor PSM, due to the large number of covariates ultimately used in the identifying model. The "curse of dimensionality" (a problem arising, in this context, from the necessity of identifying plausible matches using a large number of variables) was of some concern. To partially address this, the final PSM model included categorical measures for maternal age (e.g. <20, 21-25, 26-30) and the median household income of mother's zip code (decile indicators). All other controls were categorical by definition. The direct SES measures are maternal education (e.g. less than high school, high school, some college, 4 or more years of post-secondary education) and the mother's primary insurance payer (e.g. private/commercial, Medicaid, all others). Additional controls include race/ethnicity, nativity, marital and cohabiting status, whether or not this was the mother's first birth, the presence of pre-existing health conditions considered risk factors (non-gestational diabetes and/or hypertension, and/or a previous preterm birth) and finally the county of residence. Interactions between some of these variables were included to generate baseline equivalence (see below). In addition, this core model was re-estimated and re-calibrated to generate baseline equivalence for each separate subgroup analyzed.

The propensity scores used to identify each mother's nearest statistical neighbor were estimated via logistic regression. Multiple nearest-neighbor matches to the same observation based on the estimated propensity score (i.e. ties) are allowed and in these cases the counterfactual is the weighted average across all matches. All models were estimated in Stata 14 using the *teffects* command suite. Following Abadie and Imbens (2006 & 2016), all analyses took into account the fact that the propensity scores are estimated (not observed) when calculating the standard errors and confidence intervals for the treatment effects.[34,35]

Baseline Equivalence

A detailed description of the protocol used can be found in Sabo et al. (2019).[36] Per HomVEE criteria, "baseline equivalence" means that the differences between the treatment and matched control group for all variables used to identify matches are not statistically significant at the (α) 5% level, indicating the two groups have similar characteristics. In addition, in the analysis of the full participant population and each of the subgroups, none of the standardized differences (SDs) exceeded 0.2, a threshold often characterized as the cut-off for "small" differences.[37] Full results are reported in the Appendix, Tables 14a, 14b, and 14c. Because the matching process is based exclusively on the information reported in the birth certificates and the same treatment and matched control groups are used to evaluate each aim, the baseline equivalence results presented these tables apply to each of the outcome domains and all of the evaluation results described below.

Scientific Rigor of the Evaluation Design

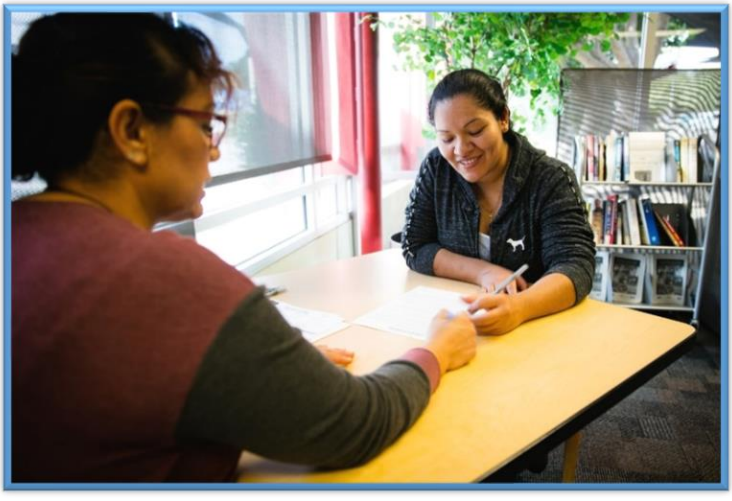
This evaluation was based on a propensity score-matched research design to ensure analytic rigor in addressing the evaluation questions and program effectiveness in general.

- ***Internal validity:*** PSM approximates a controlled, randomized experiment by using observable characteristics of the treatment group (Health Start Program participants) to generate a statistically similar synthetic control group. Comparing the maternal and child health outcomes of the control group to the Health Start Program group provides a (relatively) unbiased measure of program impact. The outcomes evaluated (birthweights and preterm birth, prenatal care utilization, immunization completion) speak directly to the behaviors and activities that Health Start Program aims to influence and improve.
- ***External validity:*** The Health Start Program operates within the unique demographic and geographic mix of Arizona's mothers and, as a result, analyses may have limited external validity for other populations. At the same time, retrospective analyses included all mothers who enrolled in the Health Start Program during 2006-2016 prior to giving birth. As a result, the analyses are highly likely to provide results descriptive of and relevant to current and future Health Start Program participants and those the program is designed to serve.
- ***Reliability:*** The processes and methods are detailed and replicable; the PSM design produces results that are accurate, unbiased, and sufficient quality to merit HomVEE's "moderate" study rating.
- ***Neutrality:*** Sources of potential bias include 1) measurement error resulting from incorrect links between Health Start Program records and birth certificate records, 2) program overlap (e.g. unobserved participation in other similar home visiting programs by both the treatment and control groups), and 3) heterogeneity in unobserved social risk factors (e.g. domestic violence, lack of family/social support, inconsistent employment) between the treatment and control groups. Making use of numerous variables to identify appropriate matches from all Arizona birth certificates, and comparing over immediate, intermediate, and long-term outcomes support the reliability of the present evaluation.

Evaluation Results

There were 966,809 total births statewide during 2006 to 2016. Among these births, 7,212 were to Health Start Program participants. Compared to all statewide births, Health Start Program participants were more likely to be aged 20-24 (34%), more likely to identify as Latina (59%) or American Indian (12%), more likely to be born in Mexico (28%), more likely to have a high school degree or GED (36%), more likely to have Medicaid insurance (83%), less likely to be married (38%) or cohabitating (62%), and have a higher rate of pre-pregnancy health risks (11%) (see Table 1aa).

Photo 1: Health Start Program CHW conducting health screen.



Of the 959,597 non-HSP births, 53,948 (5.6%) were identified as appropriate matches for Health Start Program participants (Appendix: Tables 14a, 14b, and 14c). Results are also presented at the state-level and across subgroups. Baseline equivalence between Health Start Program mothers and their matches was established by testing for statistically-significant differences of covariates between the two groups, used to estimate the propensity score and identify nearest neighbor(s). These results support the validity of the subsequent estimated treatment effects.

Aim 1: Birth Outcomes

Outcomes

- Low birthweight (LBW): birthweight less than 2500g despite gestational age
- Very low birthweight (VLBW): birthweight less than 1500g
- Extremely low birthweight (ELBW): birthweight less than 1000g
- Preterm birth (PTB): short gestational age of <37 completed weeks of pregnancy

Results

Table 6a reports the ATT effects of Health Start Program on LBW and VLBW, across five subgroups, and Table 6b reports the ATTs for ELBW and PTB. Among American Indian mothers, the LBW rate was 2.30 percentage points lower for Health Start Program mothers compared to their matched controls (3.8% vs 6.1%). Put differently, Health Start Program participation is associated with a statistically-significant 38% lower LBW rate for American Indian mothers (p-value <0.05). The LBW rate for Health Start Program mothers with pre-pregnancy health risks (diabetes and/or hypertension) is approximately 3 percentage points lower than their matched controls (9.4% vs 12.5%), indicating a statistically-significant 25% lower LBW rate for mothers with a pre-existing health risk (p-value <0.05).

Among Latina mothers, the VLBW and ELBW rates were 0.35 and 0.31 percentage points lower, respectively, for Health Start Program mothers compared to their matched controls. Health Start Program participation is associated with a statistically-significant lower VLBW rate (36%) and ELBW rate (62%) for Latina mothers (p-value <0.05). Compared to the matched control group, the PTB rate for teen mothers in the Health Start Program is 2.81 percentage points lower (9.5% vs 6.7%), a statistically-significant 30% lower PTB rate (p-value <0.05). All other outcomes were not significant at the α=0.05 level.

Table 6a: Low & very low birthweight rates & ATT, by Health Start Program subgroups.

	Low Birthweight					Very Low Birthweight				
HSP Population	HSP %	Non-HSP %	ATT	p-value*	OR	HSP %	Non-HSP %	ATT	p-value*	OR
Statewide	5.96	5.75	0.21	0.554	1.039	0.67	0.78	-0.11	0.368	0.852
Rural border counties	5.47	6.03	-0.56	0.381	0.902	0.63	0.84	-0.22	0.342	0.740
Latina	5.85	5.46	0.39	0.385	1.075	**0.63**	**0.98**	**-0.35**	**0.044**	0.642
American Indian	**3.76**	**6.05**	**-2.30**	**0.011**	0.606	0.35	0.64	-0.29	0.323	0.544
Teen mothers (age<20)	7.04	7.76	-0.72	0.455	0.900	1.19	1.23	-0.04	0.918	0.964
Pre-preg. health risk[1]	**9.42**	**12.49**	**-3.06**	**0.030**	0.729	1.10	1.63	-0.53	0.318	0.673

* ATT p-value based on estimated propensity score.
1. Pre-pregnancy health risks defined as presence of pre-existing (non-gestational) diabetes and hypertension.
HSP: Health Start Program intervention group; Non-HSP: matched control group

Table 6b: Extremely low birthweight & preterm birth rates & ATT, by Health Start Program subgroups

	Extremely Low Birthweight					Preterm Birth				
HSP Population	HSP %	Non-HSP %	ATT	p-value*	OR	HSP %	Non-HSP %	ATT	p-value*	OR
Statewide	**0.22**	**0.40**	**-0.18**	**0.031**	0.548	7.38	7.66	-0.28	0.469	0.960
Rural border counties	0.21	0.50	-0.29	0.068	0.416	5.81	6.82	-1.01	0.126	0.843
Latina	**0.19**	**0.50**	**-0.31**	**0.005**	0.377	7.16	7.66	-0.50	0.314	0.929
American Indian	0.23	0.26	-0.03	0.894	0.898	8.10	7.89	0.20	0.855	1.028
Teen mothers (age<20)	0.47	0.30	0.18	0.440	1.593	**6.65**	**9.45**	**-2.81**	**0.004**	0.682
Pre-preg. health risk[1]	0.12	0.30	-0.17	0.330	0.414	16.03	15.69	0.34	0.839	1.026

* ATT p-value based on estimated propensity score.
1. Pre-pregnancy health risks defined as presence of pre-existing (non-gestational) diabetes and hypertension.
HSP: Health Start Program intervention group; Non-HSP: matched control group

Aim 2: Prenatal Care

Outcomes

- Any prenatal care
- (At least) Adequate prenatal care, defined by the Adequacy of Prenatal Care Utilization Index (Table 7)[7]

Table 7. Adequacy of Prenatal Care Utilization Index.

	Initiation of PNC	Ratio: Received PNC/ Expected PNC
Adequate Plus	**Months 1-2**	**≥110%**
Adequate	**Months 3-4**	**80-109%**
Intermediate	Months 5-6	50-79%
Inadequate	Months 7-9 or none	<50%

Note: Per ACOG guidelines: Expected PNC visits = one visit every 4 weeks through 28 weeks, one visit every 2 weeks through 36 weeks, and one visit weekly thereafter.

Results

Table 8 reports the ATT effects of Health Start Program participation on receiving any PNC and adequate PNC across five subgroups. Participation in the Health Start Program is associated with statistically-significant increases in receipt of both any and adequate prenatal care statewide and among specific subgroups.

Compared to the matched control group, the percent of women receiving any prenatal care among all Health Start Program participants is 0.64 percentage points higher, meaning Health Start Program participation is associated with a statistically-significant 0.65% higher rate of women receiving any prenatal care (p-value <0.05). Among American Indian mothers, the rate was 1.57 percentage points higher for Health Start Program mothers compared to their matched controls, equaling a statistically-significant 1.59% higher rate of any prenatal care (p-value <0.05). The rate of any prenatal care was statistically-significantly higher among teen mothers (1.7%) and primipara mothers (0.97%) in the Health Start Program compared to their matched controls (p-value <0.05).

American Indian mothers, mothers with less than high school education, teen mothers, and primipara mothers who participated in Health Start Program had higher rates of adequate prenatal care compared to their matched controls. Health Start Program participation is associated with a statistically-significant higher rate of adequate prenatal care for American Indian mothers (6.1%), mothers with less than high school education (5.1%), teen mothers (9.8%), and primipara mothers (5.1%) (all at p-value <0.05).

Table 8: Prenatal care utilization rates & ATT, by Health Start Program subgroups.

	Any Prenatal Care					**Adequate Prenatal Care (Kotelchuck Index)**				
HSP Population	HSP %	Non-HSP %	ATT	p-value*	OR	HSP %	Non-HSP %	ATT	p-value*	OR
Statewide	**97.14**	**96.51**	**0.64**	**0.017**	1.231	**63.27**	**61.42**	**1.85**	**0.009**	1.082
Rural border counties	96.61	95.57	1.04	0.051	1.319	**61.47**	**57.76**	**3.72**	**0.004**	1.167
American Indian	**98.46**	**96.90**	**1.57**	**0.017**	2.052	56.86	55.56	1.29	0.551	1.054
Low SES[1]	95.45	94.38	1.06	0.071	1.248	**55.93**	**53.08**	**2.85**	**0.024**	1.122
Teen mothers (age<20)	**96.75**	**95.10**	**1.65**	**0.020**	1.532	**59.68**	**53.83**	**5.86**	**0.001**	1.270
Primipara[2]	**98.30**	**97.34**	**0.96**	**0.004**	1.578	**66.70**	**63.32**	**3.38**	**0.002**	1.160

* ATT p-value based on estimated propensity score.
1. Low SES: less than high school education
2. Primipara: woman giving birth for the first time
HSP: Health Start Program intervention group; Non-HSP: matched control group

Aim 3: Immunization

Outcomes

The CDC vaccination schedule for children up to age two[10] was used to measure the Aim 3 outcomes, specifically: diphtheria and tetanus toxoids and acellular or whole-cell pertussis (DTaP/DTP, 4 doses), *Haemophilus influenzae* type b (Hib, 3 or 4 doses depending on the regimen), hepatitis B (Hep. B, 3 doses), measles-mumps-rubella (MMR, 1 dose), pneumococcal conjugate vaccine (PCV13, 4 doses), poliovirus (3 doses), and varicella (1 dose) (Table 9). In each case, completion is measured by the age of the child on receipt of the last recommended dose in the series, allowing for vaccinations completed during the suggested 'catch-up' window.

Table 9. CDC-recommended immunization schedule for children 0-23 months, 2021.

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19-23 mos
DTaP/DTP			1st dose	2nd dose	3rd dose			4th dose		
Hib.			1st dose	2nd dose	*		3rd or 4th dose*			
Hep. B	1st dose	2nd dose			3rd dose					
MMR							1st dose			
PCV13			1st dose	2nd dose	3rd dose		4th dose			
Poliovirus			1st dose	2nd dose	3rd dose					
Varicella							1st dose			

Yellow: range of recommended ages for all children; Green range of recommended ages for catch-up immunization

*There are 2 accepted routine vaccinations for Hib, with different dosages: ActHIB, Hiberix, or Pentacel with 4 doses each at 2, 4, 6, 12–15 months, and PedvaxHIB with 3 doses at 2, 4, 12–15 months. *Table adapted from:* ***https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html***

Results

Table 10 reports the completion rates for the seven-vaccine series (listed in Table 9) among children enrolled in the Health Start Program compared to their matched controls, using two summary measures: 1) completion of all seven vaccinations (full completion) and 2) completion of at least five vaccinations (majority completion). Both majority and full completion rates are at least 3 percentage points higher for Health Start Program children in every subgroup, compared to their matched controls. In terms of effect sizes, relative to the rates in the matched control groups, these differences range from 3.6% (firstborn children, majority completion), to 9.1% (mothers with a pre-pregnancy health risk, full completion) and average 5.2% for majority completion and 8.5% for full completion. Moreover, the difference is statistically-significant for every group for each outcome, and highly significant ($p<0.01$) for most (15 of 16), indicating considerable effectiveness for Health Start Program with respect to promoting vaccine uptake and completion.

Table 10: Completion rates of recommended child immunization series & ATT, by Health Start Program subgroups

	Majority Completion (≥5 Vaccinations)					**Full Completion (7 Vaccinations)**				
HSP Population	HSP %	Non-HSP %	ATT	p-value*	OR	HSP %	Non-HSP %	ATT	p-value*	OR
Statewide	**85.6**	**81.2**	**4.3**	**<0.001**	1.37	**64.8**	**59.6**	**5.2**	**<0.001**	1.25
Rural border counties	**89.0**	**84.9**	**4.1**	**<0.001**	1.44	**72.0**	**66.2**	**5.8**	**<0.001**	1.31
Latino	**88.4**	**84.5**	**3.9**	**<0.001**	1.40	**68.8**	**63.2**	**5.5**	**<0.001**	1.28
American Indian	**90.8**	**86.0**	**4.9**	**0.001**	1.62	**68.7**	**63.7**	**4.9**	**0.015**	1.25
Low SES[1]	**85.9**	**81.4**	**4.5**	**<0.001**	1.40	**62.7**	**57.8**	**4.9**	**0.001**	1.23
Teen mothers (age<20)	**88.4**	**83.4**	**4.9**	**<0.001**	1.51	**66.5**	**61.0**	**5.5**	**0.002**	1.27
Firstborn	**86.2**	**83.2**	**3.0**	**<0.001**	1.26	**68.9**	**64.0**	**4.9**	**<0.001**	1.25
Pre-preg. health risk[2]	**87.5**	**82.6**	**4.9**	**0.005**	1.48	**67.4**	**61.8**	**5.6**	**0.009**	1.28

* ATT p-value based on estimated propensity score.

1. Low SES: less than high school education

2. Pre-pregnancy health risks defined as presence of pre-existing (non-gestational) diabetes and hypertension.

HSP: Health Start Program intervention group; Non-HSP: matched control group

Discussion & Interpretation of Findings

Eleven years of Health Start Program data from 2006-2016, resulted in a sample size of over 7,200 Health Start Program participant mothers. Findings from this study provide important evidence supporting the efficacy of CHW-led MCH home visiting interventions generally, and specifically CHWs' ability to address ethno-racially and geographically diverse, and socioeconomically disadvantaged population of mothers.[38] Evaluation of the programmatic impact on birthweight, prenatal care, and child immunizations relies on a substantially large sample size, long observational period, and sophisticated matching methodology.[36] Moreover, the subgroup analyses are a significant contribution to the literature regarding this type of analysis. This is the largest study of a CHW-led MCH home visiting program on incidence of birthweight, prenatal care utilization, and child immunization completion in the US to date.

Although several rigorous studies of prenatal home visitation programs exist, most utilize a combination of licensed health professionals, such as nurses and social workers to achieve outcomes.[39-41] Unique to the Health Start Program, CHWs are the sole interventionist and home visitor.[42] This evaluation of the Arizona Health Start Program is one of very few empirical studies in which CHWs are the primary interventionists that operate outside of a clinical setting and not as a member of a primary care or prenatal care coordination team.[38-40,43,44] This study further contributes to CHW effectiveness research in home visitation.

Prenatal Care and Birth Outcomes

Growing maternal and child health inequities are largely associated with multi-level social and structural determinants of health, many of which are beyond the proximal control of any individual or community.[45] Low birthweights (LBW, VLBW, ELBW) are generally accepted to be a result of PTB or fetal growth restriction and associated with several interlocking socioecological risk factors.[2,3,46,47] Women and children of color, specifically African American, Latina, and American Indian communities, experience disproportionally higher rates of LBW, VLBW and ELBW.[4,5] Adverse birth outcomes are linked to smoking,[48] poor nutrition,[49] acute stress,[50,51] prenatal depression,[52,53] short inter-pregnancy intervals,[54] relationship stress,[50] interpersonal violence,[51] lack of social support,[51] lack of access to health insurance,[51] and late or no prenatal care. From a life course perspective, LBW, VLBW, ELBW, and PTB have several implications for health equity, including cost of care,[55] decreased long-term educational attainment and earnings, and the predisposition for adult onset of chronic disease.[56-58]

While, early and adequate prenatal care is widely accepted to improve pregnancy and birth outcomes for all women, several social and structural determinants of prenatal care continue to drive disparities among ethno-racially diverse women in the US.[6,59-62] Latina and American Indian women in Arizona are more likely to have poorer pre-pregnancy health, less likely to receive adequate prenatal care, and more likely to deliver preterm and low birthweight babies compared to non-Hispanic White women.[29] Most common determinants of accessing and navigating the US maternal and child healthcare system, including prenatal care services, can include structural limitations inherent to living in a medically underserved region, being uninsured or underinsured, having access to limited providers and personnel with linguistic and cultural preparation and training, long wait times, and difficulty securing and attending prenatal appointments due to inadequate public transportation systems, demanding work schedules, and lack of childcare.[60,62]

In the US, and consistent with this study, CHWs contribute to decreased incidence of preterm birth and low birthweight, the initiation of any, early, and adequate prenatal care among health disparate populations.[18,20,24,44,63-68] The Health Start Program was effective in increasing the rate of any prenatal care among American Indian mothers, teen mothers, and primipara mothers, and adequate prenatal care utilization among mothers who reside in rural border counties, have less than a high school education, teens, and primipara mothers. Additionally, and consistent with an earlier evaluation of Health Start Program,[24] the study found that program participation was statistically significantly effective in improving birth outcomes among American Indian mothers, mothers with a pre-existing health risk, Latina mothers, and teen mothers.

Reducing the rate of adverse birth outcomes has significant financial implications. The present study found a positive program-wide treatment effect for reducing VLBW. While this is a relatively rare outcome, Johnson et al. finds that even though VLBW births represent only 1.5% of all live deliveries in the US, it accounts for 30% of newborn healthcare costs in the US. Consequently reducing this rate has the potential to have a large impact on healthcare costs.[69] The ELBW rate in the Health Start Program population is 0.28%, compared to 0.59% in the matched population. To further demonstrate the cost of this rare birth outcome, Gilbert et al. (2003) estimates that the early healthcare costs associated with a surviving ELBW infant is approximately $202,700, compared to $1,100 for a healthy infant.[70] Applying these costs to the study results suggests a savings of nearly $50 million, which itself represents only a portion of the savings that may be obtained by additionally lowering the VLBW rate.

*This Health Start Program 'treatment effect' translates to approximately 244 fewer extremely low birthweight (ELBW) births than the matched comparison group, and represents a potential **savings of nearly $50 million dollars**, only a portion of the savings generated by lowering the VLBW rate.*

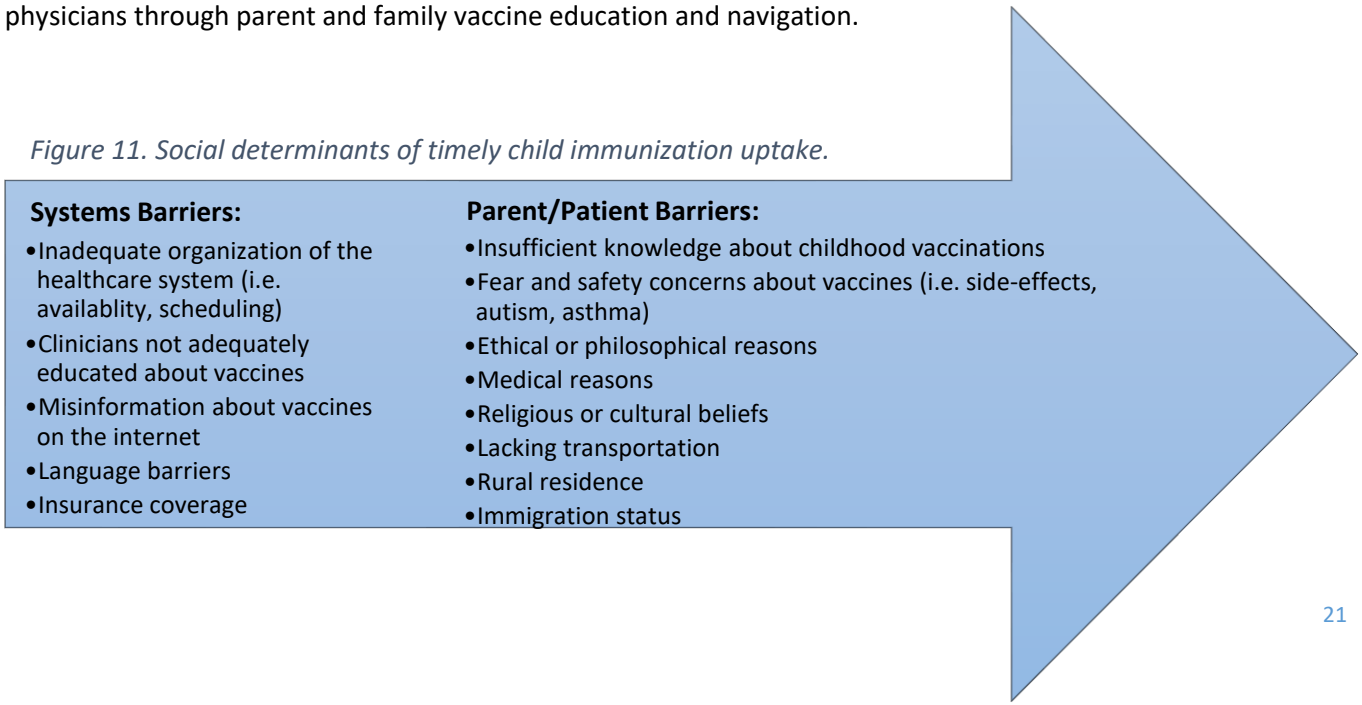
Child Immunization Uptake

A majority of children in the US are up-to-date on their vaccinations and generally adhered to the recommended ACIP immunization schedule.[71] However, disparities in income effect on-time immunization rates of children in the US, regardless of race or ethnicity.[71-74] Other social determinants that impact uptake or completion of child immunization can be grouped into systems barriers and parent/patient barriers[71-76] (Figure 12).

Findings from this study are consistent with international[77-80] and national results,[81,82] that community-based CHW programs strengthen child immunization uptake, especially within low income communities.[68] For example, targeted CHW education and home visiting strategies[81,82] and funding campaigns, such as the Vaccines for Children (VCF) program,[74,75] effectively close the vaccination uptake gap for children in low socioeconomic status and across various racial and ethnic groups in the US. As demonstrated by the Health Start Program, all participants, regardless of income, race, ethnicity, education status, or geographic location benefit from a CHW model that specifically promotes child immunization completion. All participants had higher rates of overall completion of seven CDC-recommended vaccination series.

High rates of child immunizations are associated with a substantial cost savings, with an estimated $1 spent per child vaccination resulting in up to $10 saved to society.[11] However, child vaccination promotion campaigns such as VCF may place a high burden on pediatricians, who reportedly spend a significant amount of time encouraging parents to vaccinate their children.[83] Programs like the Health Start Program, may be effective in not only encouraging and increasing child vaccination rates generally, but also in supporting clinics and physicians through parent and family vaccine education and navigation.

Figure 11. Social determinants of timely child immunization uptake.



Conclusions & Recommendations

Results from this evaluation support the growing body of evidence that CHW-led programs can have a positive impact on maternal and child health outcomes, particularly for mothers and families affected by health disparities. Several public health entities conclude that CHW-centered interventions have a positive impact in health promotion and disease prevention, in community and clinical settings.[84,85] Such recognition signals opportunity for expansion of CHW home visiting within MCH systems of care. This study provides much needed evidence to guide policymakers and practitioners on integration of CHW perinatal home visitation. The Arizona Health Start Program and its 25-year commitment to strengthening CHW maternal and child health home visiting is a healthcare innovation that can improve birthweight, prenatal care attendance, and child immunization completion among ethno-racially, socioeconomically, and geographically diverse mothers and infants in Arizona.

Recommendations Based on the Evaluation

Photo 2: Health Start Program CHW with client.

Maternal and Child Health Policy-Level

- Integrate CHWs in community-based and clinical settings; supported by the national expansion of state and tribal health departments, Medicaid systems, health plans, and provider.[84]
- Promote the use of CHWs as a cost-effective healthcare workforce able to provide patient-centered care.[86,87]
- Support CHWs as primary interventionist, to work with Latina, American Indian, rural-residing, and teen mothers to improve birthweight, prenatal care utilization, and child immunization uptake.

Health Start Program-Level

- Increase the number of allowed monthly home visits to four times per month, for all Health Start Program participants, to enable the CHWs to provide additional prenatal care accountability to every client throughout their pregnancy, which may contribute to increased positive maternal and child health outcomes.
- Provide CHWs with additional resources and training to support their capacity to connect with each client at least four times during their pregnancy.
- Encourage CHWs to check in with Health Start Program mothers prior to and after each scheduled PNC appointment to promote and improve PNC attendance, prepare for the appointment (e.g. questions), and provide follow up information as needed.
- Develop and expand transportation assistance (e.g. service, coordination, passes) to all Health Start Program sites statewide to address a potential barrier to utilizing perinatal care services (e.g. prenatal care visits, child immunization appointments).
- Strengthen education topics covered by CHWs during the prenatal period, including healthy weight and pre-existing health conditions management, because all Health Start Program mothers have at least one social and medical risk factor that puts them at increased risk for a health issue, such as diabetes or hypertension, and subsequently at higher risk for preterm birth and low birthweight outcomes.

The additional support, encouragement, education, and resources from CHWs may promote and increase any and adequate prenatal care utilization, reduce the rates of low birthweight and preterm birth, and continue the high rate of child immunization completion of all Health Start Program mothers.

Evaluation Successes, Challenges, & Lessons

Successes

The evaluation team shares a passion for maternal and child health and community health workers. The longstanding relationships and trust built between the Arizona Department of Health Services, and the evaluation team members at University of Arizona and Northern Arizona University contributed greatly to the evaluation process. The evaluation, designed to take full advantage of the depth of the Health Start Program and the breadth of the informational resources made available through ADHS, includes a substantially larger sample size, longer observational period, more sophisticated matching methodology, and significant subgroup analyses than previous studies.[24,36] Access to 11 years of Health Start Program enrollment data and birth certificates permitted us to generate an analytic sample size sufficient to detect meaningful program effects. The scale of the administrative and program data highlights where and for whom Health Start Program has been most effective, including birth outcomes that are associated with heavy spending (e.g. low, very low, and extremely low birthweights). Additionally, because Health Start Program CHWs conduct home visits independently (i.e. without a nurse or other provider), this evaluation is one of very few empirical studies that include CHWs as the primary interventionists and offers a unique contribution to the growing CHW peer reviewed literature.

Evaluation results support the growing body of evidence that CHW-led programs can have a positive impact on maternal and child health outcomes, particularly for mothers and families affected by health disparities. This study underscores the importance of understanding for whom the program is most beneficial, an understanding which can help administrators efficiently target outreach and enrollment resources.

Photo 3: Health Start Program CHWs.

Challenges

By design, Health Start Program serves a geographically and demographically diverse population of mothers characterized by high rates of socioeconomic and health risk factors. These comprise the most significant set of confounding factors with respect to evaluating program impacts, but are controlled for explicitly via the logistic regression used to estimate the propensity score, and implicitly via the propensity score match study design. A second significant factor that may contribute to increased variance in program effectiveness is heterogeneity in program participation. In addition to controlling for this heterogeneity in the logistic regressions and subsequent matching, the subgroup analyses represent an extra step in accounting for potential variance in program effects. Most of the challenges of the evaluation derive from the advantages and features that made it possible and worthwhile; namely, data preparation and transfer arrangements between the different agencies (ADHS, the Honest Broker at the University of Arizona, and the evaluation/analytics group). These arrangements required patience, persistence, and flexibility of all parties involved, which, happily, was consistently given and ultimately made a project of this scope possible.

The change in the birth certificate format in 2014 limited the information that was available across the entire study period. Thanks to the guidance and hands-on assistance of ADHS personnel, meaningful and consistent measures were identified or created to enable evaluation of a longer time period and the statistical power to investigate program effects on low-frequency events. The matching process itself presented another challenge. Baseline equivalence and balance had to be achieved for each subgroup analyzed, which means that the original model had to be re-calibrated and customized numerous times.

Finally, the global pandemic presented a significant challenge. Many team members were asked to participate in time-sensitive pandemic-related working groups, which again, meant that patience, persistence, and flexibility were required to keep this project on track.

Lessons Learned

The current evaluation of the Health Start Program relied on administrative enrollment data, which was linked to birth certificate data to assess the associative effect of the program on maternal and child health outcomes. The scale of the administrative and program data has enabled us to show where and for whom Health Start Program has been most effective, with respect to observable health outcomes. This is especially true for those events that occur infrequently (e.g. very low birth weight), but which are also associated with high cost and spending.

There is still much left to understand with respect to the mechanisms behind the program's success. Future program evaluation of the Health Start Program components would provide a deeper understanding of the connection between the CHW-provided activities, participant actions, and short and long term indicators of healthy perinatal birth outcomes. There is opportunity for future research to use program participation data to assess specific CHW activities and other program features and their associations with the positive impacts presented in this report.

Results from this study champion the dedication Health Start Program *promotoras* and community health workers have to maternal and child health across the state. Results will be shared with the communities served by the Health Start Program, which may lead to increased support from clinics, providers, funders, insurance, and other agencies.

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Appendix

Table 11. Timeline of Health Start Program evaluation activities.

7/1/2018 – 6/30/2019	7/1/2019-6/30/2020	7/1/2020-6/30/2021	7/1/2021-6/30/2022*
• Monthly Project Meetings • Propensity Score Matching • Manuscript development (protocol paper) • Data analysis (Aim 1)	• Monthly Project Meetings • Data analysis (Aim 2) • Manuscript development (Aims 1 & 2) • Data acquisition (Aim 3)	• Monthly Project Meetings • Manuscript submission (Aims 1 & 2) • Data analysis (Aim 3) • ADHS Final Impact Report submission	• Monthly Project Meetings • Manuscript development (Aim 3) • Manuscript submission (Aim 3) • Community Report

*Proposed activities.

Table 12. Arizona Health Start Program FY22 Contractors Contact List

ARIZONA DEPARTMENT OF HEALTH SERVICES

Site	Coordinator	Email	Phone
Apache Co. Health Dept. 75 W. Cleveland St. PO Box 697 St. Johns, AZ 85936	Laura Salazar APACHE COUNTY	lsalazar@co.apache.az.us	928-337-7519
Adelante Healthcare 13471 W. Cornerstone Blvd Goodyear, AZ 85395	Cecilia Fernandez Goodyear/Buckeye MARICOPA COUNTY	cfernandez@adelantehealthcare.org	623-583-3001 Ext 011321
Cochise Health & Social Services 4115 E. Foothills Drive Sierra Vista, AZ 85635	LaRae Swartz COCHISE COUNTY	LSwartz@cochise.az.gov	520-803-3923
Coconino Co. Health and Human Services 467 Vista Ave. PO Box 970 Page, AZ 86040	Brooke Holiday COCONINO COUNTY	Bholiday@coconino.az.gov	928-679-7295 928-679-7292
Mariposa Community Health Center 1852 N. Mastick Way Nogales, AZ 85621	Rosie Simpson SANTA CRUZ COUNTY	rxsimpson@mariposachc.net	520-375-6050 Ext 1360
Mohave Co. Dept. of Public Health 700 W. Beale Street Kingman, AZ 86401	JoBeth Giovanardi MOHAVE COUNTY LAPAZ COUNTY	Jobeth.Giovanardi@mohavecounty.us	928-753-0714 Ext 4323
Native American Community Health Center 777 W. Southern Ave, Bldg. C Mesa, AZ 85210 4041 N. Central Ave., Bldg. C Phoenix, AZ 85012	Carri A. Chischilly MARICOPA COUNTY	cchischilly@nachci.com Shighsmith@nachci.com	602-550-4048 Ext 3806 602-279-5262 Ext 3315
North Country HealthCare 2920 N. 4th Street Flagstaff, AZ 86004	Pearl Santillan COCONINO	psantillan@nchcaz.org	928-522-9430

North Country HealthCare 126 E Main St. STE. B Payson, AZ 85541	Perla Guereque - Dodge GILA COUNTY	pguereque@nchcaz.org	928-472-3752
North County HealthCare 2109 Navajo Blvd. Holbrook, AZ 86025	Deborah Lewis, M.Ed. NAVAJO COUNTY	dslewis@nchcaz.org	928-524-2851 Ext 7256 928-532-6952 (Show Low)
North County HealthCare 488 S. Mountain Ave. Springerville, AZ 85938	Deborah Lewis, M.Ed. Southern APACHE COUNTY	dslewis@nchcaz.org	928-333-0127
Pima County Health Dept. 3950 S. Country Club Rd., Suite 100 Tucson, AZ 85714-2056	Victoria Altamirano PIMA COUNTY	Victoria.altamirano@pima.gov	520-724-3961
San Carlos Apache Tribe 103 Medicine Way Peridot, AZ 85542 PO Box 0 San Carlos, AZ 85550	Jana Zospah/ Melinda Goode GILA COUNTY GRAHAM COUNTY	Jana.zospah@scat-nsn.gov Melinda.good@scat-nsn.gov	928-475-1576 928-200-3256
Tempe Community Action Agency 2146 Apache Blvd Tempe, AZ 85281	Rosario Fuentes MARICOPA COUNTY	Rosariof@tempeaction.org	480-350-5877
Unlimited Potential 3146 E. Weir Ave. Room 34 Phoenix, AZ 85040 PO Box 8814 Phoenix, AZ 85066	Emma Viera, PhD, MPH/Anna Guzman MARICOPA COUNTY	Executivedirector@unlimitedpotentialaz.org aguzman@unlimitedpotentialaz.org	602-305-4741
Yavapai County Community Health Services 1090 Commerce Drive Prescott, AZ 86305	Megan Steward, RN YAVAPAI COUNTY	megan.steward@yavapai.us Carol.Espinosa@yavapai.us	928-442-5617 928-442-5478
Yuma County Public Health Services District 2200 W. 28th St. Suite 256 Yuma, AZ 85364	Joan Castillo YUMA COUNTY LAPAZ COUNTY	Joan.Castillo@yumacountyaz.gov	928-317-4653

Table 13. Health Start Client Demographic Information, by county, 2006-2016.

		Age				Education				Insurance Type			Race/Ethnicity			
County	N	<20	20-24	25-30	>30	<High School	High School Degree	Some College	College Degree	Private/ Commercial	AHCCCS	Other	White	American Indian	Latino	Other
2 Cochise	784	25.8%	43.1%	19.3%	11.9%	30.2%	38.9%	27.3%	3.4%	15.3%	82.1%	2.6%	28.1%	0.3%	64.8%	6.9%
3 Coconino	587	20.8%	32.5%	29.5%	17.2%	30.0%	40.0%	19.3%	10.7%	15.5%	83.3%	1.2%	38.2%	34.1%	23.3%	4.4%
7 Maricopa	1905	14.8%	31.1%	30.8%	23.3%	39.2%	31.8%	21.9%	6.9%	13.6%	84.1%	2.3%	14.2%	25.2%	55.3%	5.2%
8 Mohave	303	17.5%	39.6%	24.8%	18.2%	27.7%	44.9%	23.8%	3.6%	8.3%	88.1%	3.6%	55.8%	1.0%	37.3%	5.9%
9 Navajo	274	15.3%	42.3%	30.3%	12.0%	25.5%	38.7%	33.6%	2.2%	14.6%	83.6%	1.8%	54.0%	21.9%	19.3%	4.7%
10 Pima	649	10.6%	30.8%	32.8%	25.7%	35.6%	29.9%	23.6%	10.9%	14.6%	80.7%	4.6%	23.4%	2.9%	57.5%	16.2%
12 Santa Cruz	427	25.3%	26.9%	25.3%	22.5%	37.2%	34.0%	20.4%	8.4%	8.2%	87.1%	4.7%	1.9%	0.0%	97.4%	0.7%
13 Yavapai	373	14.7%	31.9%	29.0%	24.4%	51.2%	34.3%	10.5%	4.0%	5.1%	92.8%	2.1%	19.8%	0.5%	78.8%	0.8%
1 Apache 5 Graham, 6 Greenlee*	360	12.8%	36.7%	31.4%	19.2%	23.6%	34.4%	39.2%	2.8%	21.7%	75.8%	2.5%	55.0%	12.5%	31.1%	1.4%
14 Yuma, 15 La Paz*	1184	17.1%	37.7%	28.3%	17.0%	25.5%	39.3%	25.9%	9.0%	14.2%	82.3%	3.5%	10.6%	1.2%	85.4%	2.9%
4 Gila, 11 Pinal*	237	24.5%	34.6%	25.7%	15.2%	31.6%	38.8%	23.6%	5.9%	21.1%	75.5%	3.4%	52.7%	6.8%	37.6%	3.0%
Arizona	**7218**	**17.5%**	**34.4%**	**28.4%**	**19.7%**	**33.1%**	**35.7%**	**23.8%**	**7.4%**	**13.7%**	**82.5%**	**3.8%**	**24.0%**	**11.8%**	**59.1%**	**5.1%**

*Proximal counties combined due to small cell sizes in sparsely populated areas

Table 14a: Baseline Matching (Equivalence) Results for Statewide & Rural Border County

	Statewide					Rural Border Counties				
	All AZ Births	HSP	Non-HSP	p-value	SD	All AZ Births	HSP	Non-HSP	p-value	SD
N	966,809	7,212	53,948			55,223	2,393	7,045		
Maternal age										
Age<20	9.9	17.5	16.9	0.321	0.017	12.4	21.4	21.3	0.944	0.013
Age 20-24	25.3	34.4	34.8	0.564		29.8	37.5	37.5	0.976	
Age 25-30 (ref)	34.0	28.4	28.6	0.825		33.7	24.8	24.4	0.763	
Age>30	30.8	19.7	19.7	1.000		24.1	16.3	16.7	0.697	
Race/ethnicity										
White	42.4	24.0	23.7	0.653	0.027	28.2	14.7	15.4	0.492	0.054
American Indian	6.0	11.8	12.0	0.700		1.0	0.6	0.6	0.852	
Latina	41.8	59.1	59.7	0.436		65.9	80.9	81.1	0.825	
Other race/ethnicity (ref)	9.8	5.1	4.6	0.142		4.9	3.8	2.9	0.077	
Maternal nativity										
Mother born in US (ref)	73.6	68.6	69.2	0.461	0.014	68.4	68.4	69.8	0.288	0.045
Mother born in Mexico	18.7	27.9	27.5	0.602		27.8	30.1	29.1	0.448	
Mother born outside US	7.6	3.5	3.3	0.550		3.8	1.5	1.1	0.201	
Mother's education										
Less than high school (ref)	21.7	32.7	32.9	0.811	0.052	22.2	29.1	29.2	0.936	0.037
High school/GED	28.8	35.7	35.7	0.972		34.9	38.2	39.2	0.458	
Some post-secondary	25.2	23.8	23.5	0.710		26.0	25.4	24.3	0.385	
4-year degree or more	22.5	7.3	7.0	0.420		16.1	7.1	6.9	0.821	
Education missing	1.7	0.3	0.7	0.003		0.7	0.1	0.2	0.489	
Insurance/payer										
Private/commercial insurance	41.1	13.7	13.7	0.904	0.014	36.5	13.5	12.7	0.391	0.025
Medicaid	53.8	82.5	82.8	0.613		56.2	83.1	84.0	0.413	
Other insurance (ref)	5.1	3.8	3.5	0.424		7.3	3.4	3.3	0.936	
Married	54.5	37.8	37.4	0.680	0.007	56.3	39.1	37.7	0.342	0.027
Cohabiting	75.6	62.4	62.8	0.570	0.014	71.6	58.5	58.8	0.814	0.009
First birth	36.9	41.6	40.5	0.160	0.023	36.3	51.8	51.0	0.563	0.017
Pre-pregnancy health risk	8.3	11.3	10.8	0.276	0.018	7.4	9.8	8.5	0.120	0.045

SD: Standardized Difference. HSP: Health Start Program; Non-HSP: Comparison group identified via propensity-score. All models control for median income at the zip code level, county of residence, and year of birth. Participant subgroups matching models may include additional interactions between controls in order to achieve baseline equivalence. Full tables available upon request.

Table 14b: Baseline Matching (Equivalence) Results for Latina and American Indian

	Latina					American Indian				
	All AZ Births	HSP	Non-HSP	p-value	SD	All AZ Births	HSP	Non-HSP	p-value	SD
N	404,188	4,259	32,502			58,358	852	2,259		
Maternal age										
Age<20	14.2	18.5	17.8	0.431	0.020	16.0	18.8	17.1	0.377	0.043
Age 20-24	29.5	33.3	33.1	0.890		32.0	35.8	36.4	0.801	
Age 25-30 (ref)	31.4	27.3	27.6	0.752		29.9	28.6	29.1	0.831	
Age>30	25.0	21.0	21.5	0.578		22.1	16.8	17.4	0.748	
Race/ethnicity										
White	0.0	0.0	0.0		0.000	0.0	0.0	0.0		0.000
American Indian	0.0	0.0	0.0			100.0	100.0	100.0	1.000	
Latina	100.0	100.0	100.0	1.000		0.0	0.0	0.0		
Other race/ethnicity (ref)	0.0	0.0	0.0			0.0	0.0	0.0		
Maternal nativity										
Mother born in US (ref)	52.1	51.8	52.6	0.474	0.024	99.2	99.9	99.2	0.037	0.101
Mother born in Mexico	44.3	46.9	46.3	0.602		0.2	0.0	0.5	0.034	
Mother born outside US	3.6	1.3	1.1	0.372		0.5	0.1	0.3	0.465	
Mother's education										
Less than high school (ref)	36.6	38.8	39.9	0.304	0.027	27.6	31.0	28.5	0.261	0.075
High school/GED	33.0	35.1	34.5	0.570		38.3	40.3	42.6	0.326	
Some post-secondary	19.6	19.5	18.9	0.441		26.9	26.2	26.8	0.784	
4-year degree or more	10.1	6.2	6.2	0.893		6.3	2.1	1.5	0.365	
Education missing	0.5	0.3	0.3	0.710		0.8	0.5	0.6	0.808	
Insurance/payer										
Private/commercial insurance	23.7	10.1	9.7	0.491	0.016	12.3	5.2	5.3	0.913	0.032
Medicaid	70.3	84.9	85.4	0.483		85.0	93.4	93.7	0.844	
Other insurance (ref)	6.0	5.0	4.9	0.842		2.7	1.4	1.1	0.510	
Married	43.0	39.4	39.7	0.740	0.007	21.5	14.3	12.3	0.226	0.059
Cohabiting	71.0	63.6	63.8	0.822	0.005	53.7	50.5	50.8	0.885	0.098
First birth	33.7	40.7	39.8	0.414	0.018	31.7	34.5	34.9	0.879	0.007
Pre-pregnancy health risk	8.0	10.7	10.1	0.357	0.020	14.6	16.4	15.7	0.693	0.019

SD: Standardized Difference. HSP: Health Start Program; Non-HSP: Comparison group identified via propensity-score. All models control for median income at the zip code level, county of residence, and year of birth. Participant subgroups matching models may include additional interactions between controls in order to achieve baseline equivalence. Full tables available upon request.

Table 14c: Baseline Matching (Equivalence) Results for Teen Mothers and Mothers with Pre-existing Health Risks[1]

	Teen Mothers (Age<20)					Mothers with Pre-pregnancy Health Risks[1]				
	All AZ Births	HSP	Non-HSP	p-value	SD	All AZ Births	HSP	Non-HSP	p-value	SD
N	95,750	1,264	6,810			79,912	817	2,101		
Maternal age										
Age<20	100.0	100.0	100.0	1.000	0.000	3.8	5.9	5.1	0.516	0.045
Age 20-24	0.0	0.0	0.0			16.6	25.7	26.1	0.866	
Age 25-30 (ref)	0.0	0.0	0.0			33.1	34.9	33.8	0.639	
Age>30	0.0	0.0	0.0			46.5	33.5	35.0	0.532	
Race/ethnicity										
White	23.9	22.2	22.9	0.669	0.065	37.3	20.9	20.2	0.714	0.023
American Indian	9.7	12.7	12.1	0.673		10.7	17.1	17.5	0.845	
Latina	59.7	62.2	63.0	0.681		40.7	55.9	56.5	0.803	
Other race/ethnicity (ref)	6.6	2.9	2.0	0.123		11.4	6.0	5.8	0.833	
Maternal nativity										
Mother born in US (ref)	79.7	83.2	84.8	0.286	0.043	74.4	66.8	66.2	0.793	0.014
Mother born in Mexico	18.3	16.1	14.6	0.295		17.3	27.7	28.3	0.783	
Mother born outside US	2.0	0.6	0.6	0.861		8.3	5.5	5.5	1.000	
Mother's education										
Less than high school (ref)	55.3	57.6	57.3	0.876	0.043	20.1	29.4	31.4	0.381	0.044
High school/GED	36.4	34.7	35.2	0.802		27.2	34.5	33.5	0.676	
Some post-secondary	7.6	7.3	6.9	0.698		30.2	30.0	29.1	0.705	
4-year degree or more	0.0	0.0	0.1	0.267		21.4	5.8	5.5	0.830	
Education missing	0.6	0.3	0.3	0.989		0.8	0.2	0.3	0.873	
Insurance/payer										
Private/commercial insurance	11.6	6.0	5.4	0.493	0.027	41.5	13.6	13.6	1.000	0.073
Medicaid	84.4	90.6	91.1	0.629		54.8	84.1	82.9	0.506	
Other insurance (ref)	4.0	3.4	3.5	0.913		3.7	2.3	3.5	0.143	
Married	12.0	11.7	11.3	0.755	0.012	56.8	43.2	45.2	0.426	0.039
Cohabiting	48.6	41.9	42.3	0.809	0.020	76.6	68.1	70.3	0.335	0.103
First birth	80.6	80.8	82.6	0.237	0.047	28.4	30.7	29.9	0.706	0.019
Pre-pregnancy health risk	3.1	3.8	3.6	0.834	0.008	100.0	100.0	100.0	1.000	

1. Pre-pregnancy health risks defined as presence of pre-existing (non-gestational) diabetes and hypertension. SD: Standardized Difference. HSP: Health Start Program; Non-HSP: Comparison group identified via propensity-score. All models control for median income at the zip code level, county of residence, and year of birth. Participant subgroups matching models may include additional interactions between controls in order to achieve baseline equivalence. Full tables available upon request.