Received: 20 April 2023 | Revised: 30 June 2023 | Accepted: 12 July 2023

DOI: 10.1002/pd.6409

ORIGINAL ARTICLE

PRENATAL DIAGNOSIS WILEY

Prenatal detection of congenital heart disease: Recent experience across the state of Arizona

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Abstract

Objective: To determine the prenatal detection rate (PDR) of congenital heart disease (CHD) in Arizona as well as describe various factors that may influence detection rates.

Methods: This was a retrospective chart review using the Society of Thoracic Surgeons and Phoenix Children's Fetal Cardiology databases. We included all cases of CHD requiring surgery <1 year of age between 2013 and 2018. A total of 1137 patients met the criteria, and various demographic, socioeconomic, and patient outcome data were collected.

Results: The overall PDR was 58% with an improving detection rate over the course of our study, with the final year having a PDR of 67%. Over time, PDR improved in urban communities, but this was not seen in rural communities. Rural address, public insurance, and Native American ethnicity were associated with lower PDR. Postnatal outcomes, including Apgars, initial pH, and lactate, did not differ with the presence of a prenatal diagnosis. Diagnoses typically identified with the outflow tract and 3-vessel views on the fetal echocardiogram were less likely to be detected prenatally.

Conclusions: The PDR of CHD continues to improve with evolving technologies and guidelines. We highlight a discrepancy between urban, rural, and Native American populations. Additionally, by supplying descriptors of missed diagnosis and associated echocardiography views, we hope to provide data for future interventions.

Key points

What is already known about this topic?

- The national average prenatal detection rate (PDR) of congenital heart disease is only about 50%
- Factors associated with lower PDR include younger maternal age, less education, and further distance to the nearest hospital

Subsections of our study's data have been presented at the following conferences. Conferences: Improving Rate of Prenatal Detection of Congenital Heart Disease in Arizona. CHOP Cardiology Annual Update 2022. Healthcare Deserts: Prenatal Detection of Congenital Heart Disease in Arizona. Neoheart Conference 2022. The statistically significant findings and synthesis of our full data set have never been presented/published.

What this study adds?

- Residence in a rural community, public insurance, and Native American ethnicity were associated with lower PDR
- Improvements in the PDR over the course of the study were driven by the urban population

1 | INTRODUCTION

Congenital heart disease (CHD) is the most common congenital anomaly, with a prevalence of 8/1000 live births.[1] About 30% of these children require an intervention (surgical or catheter-based) in the first year of life, a subset called major CHD. The overall mortality rate for this group ranges between 13% and 18%.[2] Critical CHD is a more severe subset of CHD and is defined as infants needing intervention in the first 28 days of life, requiring significant medical and surgical care to ensure survival.[3,4] Prenatal detection of CHD allows for early parental counseling and improved perinatal management, including delivery planning and potential interventions. Studies have shown that patients with a prenatal diagnosis (PND) were admitted to the hospital earlier and had less time for surgery.[5,6] The prenatal detection is associated with decreased pre-operative morbidity as well as lower pre-operative risks including less likely to require mechanical ventilatory support, shock, renal dysfunction, or cardiopulmonary resuscitation.[5,7,8]

Previous studies highlighted rates of prenatal detection as well as identified various factors that influence detection. Despite advancements in ultrasound technology and updated screening guidelines, the national average prenatal detection rate (PDR) of CHD is only about 50% (range 34%–65%). There has been a trend of improved detection rates over the past 15 years; however, there is still significant room for improvement.[9–11] Factors associated with a lower PDR include mothers who are of younger age, have fewer years of education, and have longer travel time to the nearest hospital. Our institution's patient demographic is somewhat unique as only about half identify as Caucasian, 3% identify as fully Native American, and roughly 42% live in rural zip codes according to the rural-urban commuting area (RUCA) score assigned by the Health Resources and Services Administration (HRSA). Many regions within the state have limited access to healthcare and therefore prenatal care. Previous studies from 2008 to 2012 determined that the PDR for the state of Arizona was estimated to be between 40% and 50%.[9] The aim of this study was to provide updated detection rates for CHD in the state of Arizona, as well as gain better insight into factors that can potentially alter prenatal detection rates.

2 | METHODS

In an effort to improve prenatal detection of CHD, we conducted a retrospective cohort study. Our inclusion criteria consisted of all infants with hemodynamically significant CHD (major CHD) requiring cardiac surgery at <1 year of age between the years 2013–2018 in the state of Arizona. This data was acquired using the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database. Phoenix Children's Hospital is the only tertiary care center in the state, performing nearly all of the pediatric cardiology surgical cases and the only center that reported to STS during this interval. We also used the Phoenix Children's Fetal Cardiology Database to determine the number of CHD cases that resulted in termination or intrauterine fetal demise during the specified time interval. A fetal diagnosis of CHD could be determined by either a maternal fetal medicine physician or pediatric cardiologist. Chart review was carried out for each case and coded using the Center for Disease Control recommended ICD-10-DM codes. If a patient had complex heart disease with multiple diagnoses, the most significant defect was assigned.

Maternal data collected included ethnicity, zip code of residence, prenatal care details, fetal diagnosis of CHD, delivery hospital, and delivery method. Infant variables collected included gestational age, birth weight, Apgar scores, initial pH, initial lactate, postnatal cardiac diagnosis, time to postnatal diagnosis, concurrent syndromes/genetic abnormalities, and time to first cardiac surgery. Fetal demise and termination cases were used in calculating the PDR as well as cardiac diagnosis rates but not included outcomes data analysis.

2.1 | Definitions

The RUCA score is an assigned value given to each zip code in the US by the USDA Economic Research Service. Scores are whole numbers ranging from 1 to 10 (with 1 being most urban and 10 being most rural) and delineate metropolitan, micropolitan, small town, and rural areas based on the size, population, and primary commuting flows. The HRSA further defined geographic areas with RUCA scores of 1–3 as urban, while scores 4–10 are considered rural. Ethnicity was self-reported.

Prenatal care, fetal diagnosis of CHD and genetic abnormalities were assigned binomial values (Y/N). Sufficient prenatal care was defined as starting prior to the third trimester and ≥3 visits.

High-risk pregnancy was defined by the US Department of Health and Human Services office of women's health as one where mother or fetus or both are at higher risk for problems during pregnancy that typically, and often require specialized care from specially trained providers. Examples of this included high-risk maternal age (<18 years old or >35 years), maternal comorbidities (uncontrolled diabetes, morbid obesity prior to pregnancy, autoimmune disorders, cancer, HIV, preeclampsia), and multiple gestations. Fetal diagnosis of CHD was excluded as a pregnancy risk factor. Mothers without these conditions were deemed as low risk.

Insurance was divided into 2 groups—public and private. A large portion of the Arizona population is Native American and has Indian Health Services insurance. This insurance has its own branch within the Medicaid system and was considered public insurance for this analysis.

- Public = Medicaid, Indian Health Services, out of state (non-private)
- Private = commercial, state-specific (private), and military

Critical CHD was defined per the Metropolitan Atlanta Congenital Defects Program definition.[3] Diagnoses included hypoplastic left heart syndrome (HLHS), pulmonary atresia, Tetralogy of Fallot, D-transposition of the great arteries (D-TGA), tricuspid atresia, truncus arteriosus, and total anomalous pulmonary venous return, coarctation of the aorta, interrupted aortic arch, double outlet right ventricle, Ebstein's anomaly, and other single ventricle variants. Critical CHD was defined as requiring intervention within the first 28 days of life. Major CHD is defined as those requiring intervention within the first 1 year of life.

2.2 | Statistical analysis

The data will be summarized using frequencies and proportions for categorical variables. The univariate association between each risk factor and prenatal CHD detection was tested using the Chi-squared test or the Fisher's exact test. Univariate and multivariate logistic regression analyses were used to model and predict the probability of prenatal CHD detection and to examine its association in relation to multiple risk factors simultaneously. The results were summarized using the difference in probability, standard error, corresponding 95% confidence interval (95% CI) and *p*-value for significance. All statistical tests were 2-sided with significance evaluated at the 5% level. Statistical analyses were performed using the statistical software packages SAS 9.4 (SAS Institute).

2.3 | Power and sample size

Based on a total sample size of 1137 subjects, the proportion of prenatal CHD detection will be estimated with a 95% confidence interval within a margin of error of 3%, assuming a prevalence proportion of 50%. The total sample size of 1137 will also provide statistical power of 80% to conclude statistical significance to test a univariate association between the prenatal CHD detection and the RUCA risk factor corresponding to a small effect size of an odds ratio of 1.05, assuming a prenatal CHD detection rate of 50%, and a univariate association between the prenatal CHD detection and high-risk pregnancy (yes vs. no) corresponding to a difference of 10% assuming a reference PDR of 50% and equal sample size, using a chi-square test corresponding to a 2-sided test. The power was conducted using the power procedure in SAS.

3 | RESULTS

There were 129 cases of fetal demise/termination and 1008 cases of CHD that required surgery before 1 year of age, meeting our inclusion criteria. Characteristics are displayed in Table 1. The overall PDR in this cohort was 58% (662/1137, 95% CI 55.3%–61.1%).

3.1 | Maternal and fetal variables

3.1.1 | Pregnancy risk

High-risk pregnancies (presence of CHD was excluded from this definition) had a higher PDR (61.7% vs. 51.2%, *p*-value 0.0033). 44.5% of the cases (449/1008) met the criteria for a high-risk pregnancy. In our population, the most common reasons for high-risk pregnancy classification were advanced maternal age, multiple gestation, and maternal diabetes. 777 cases reported adequate prenatal care (77.2%), 52 cases were documented as having no/insufficient prenatal care (5.2%), and information was missing in 179 patient charts (17.8%).

3.1.2 | Chromosomal abnormalities, genetic syndromes, or associations

The presence of a chromosomal abnormality, genetic syndrome, or other known associations had a higher PDR (62.4% vs. 46.6%, *p*-value <0.0001). 39.6% of patients met these criteria (399/1008 patients). Either prenatal/postnatal genetic testing or clinical diagnosis by a geneticist assigned patients a diagnosis. The most common conditions included trisomy 21 (154 patients), heterotaxy (48 patients), 22q11 (27 patients), and VACTERL (20 patients) (see Table 2).

3.2 | Sociodemographic variables

3.2.1 | RUCA score

The PDR of CHD was significantly lower in rural RUCA zip codes as compared to urban ones (35.9% vs. 54.8%, *p*-value 0.0003). 89.8% of the patients lived in an urban zip code (905/1008 patients) while 10.2% lived in rural areas. Zip codes were grouped by county to show regional differences in prenatal detection. This is demonstrated in Figure 1.

3.2.2 | Insurance

Public insurance comprised 61% of the cases, while 34.6% had private insurance. The PDR was significantly lower for those with public insurance versus private insurance (50.1% vs. 59%, *p*-value 0.0078).

TABLE 1 Demographic data of out patient population along with the corresponding prenatal detection rate.

Patient variable	Demographic grouping	Total number (% of total)	Prenatal detection		PDR (%)	*p*-value
			Yes	No		
Total		1135	662	473	58.3	
Prenatal care	None/late	52 (5.2%)	9	43	17.3	<0.0001
	Yes	777 (77.2%)	488	289	62.8	
	Data missing	179 (17.8)	36	143	18.7	
Pregnancy risk	Low risk	334 (33.1%)	171	163	51.2	0.0033
	High risk	449 (44.5%)	277	172	61.7	
Genetic/syndrome abnormality or association	Yes	399 (39.6%)	249	150	62.4	<0.0001
	No	609 (60.4%)	284	325	46.6	
RUCA score	Urban (RUCA 1–3)	905 (89.8%)	496	409	54.8	0.0003
	Rural (RUCA 4–10)	103 (10.2%)	37	66	35.9	
Insurance	Public	615 (61.0%)	308	307	50.1	0.0078
	Private	349 (34.6%)	206	143	59.0	
Ethnicity	African American/Asian/other	92 (9.1%)	55	37	59.8	0.068
	Hispanic	351 (34.8%)	188	163	53.6	
	Native American	69 (6.8%)	27	42	39.1	
	White	490 (48.6%)	262	228	53.5	
	Native American	69 (6.8%)	27	42	39.1	0.016
	All other ethnicities	933 (92.6%)	505	428	54.1	

Abbreviations: PDR, prenatal detection rate; RUCA, rural-urban commuting area.

TABLE 2 Demonstrates the various genetic abnormalities, syndromes, or associations seen in our population (if condition had $N \geq 2$).

Genetic/syndrome or association	# of cases
Trisomy 21	154
Heterotaxy	48
22q11	27
VACTERL	20
Turner	8
Goldenhar	6
Apert	2
Pierre Robin	2

3.2.3 | Ethnicity

The rate of prenatal detection was determined for each reported ethnicity. Native American ethnicity had a significantly lower PDR compared with all other ethnicities (39.1% vs. 54.1%, $p = 0.016$). The PDR from lowest to highest ethnicity was Native American (39.1%), White (53.5%), Hispanic (53.6%), African American (59.3%) and Asian (66.7%).

3.2.4 | Multivariable logistic model

A multivariable logistic model was applied for the above socio-demographic variables, summarized in Table 3. Insurance and RUCA scores independently predicted PDR (*p*-values of 0.025 and 0.006 respectively). Ethnicity—specifically Native American ethnicity versus other ethnicities—did not independently predict PDR with a *p*-value of 0.176.

3.3 | Diagnostic variables

The PDR for specific cardiac diagnoses is shown in Figure 2. The defects with the highest PDR included HLHS (90%), Ebstein's anomaly (89%), and tricuspid atresia (88%). Defects with the lowest detection rates included isolated ventricular septal defects (VSDs) (31%) vascular rings (12%), and total anomalous pulmonary venous return (10%). Additionally, we grouped defects into broader categories by type as well as by fetal echocardiographic view most likely to detect the abnormality (described previously by Hill et al.).[12]

Single ventricle variants had the highest PDR of 84%, followed by atrioventricular canal defects (72.4%), and conotruncal abnormalities

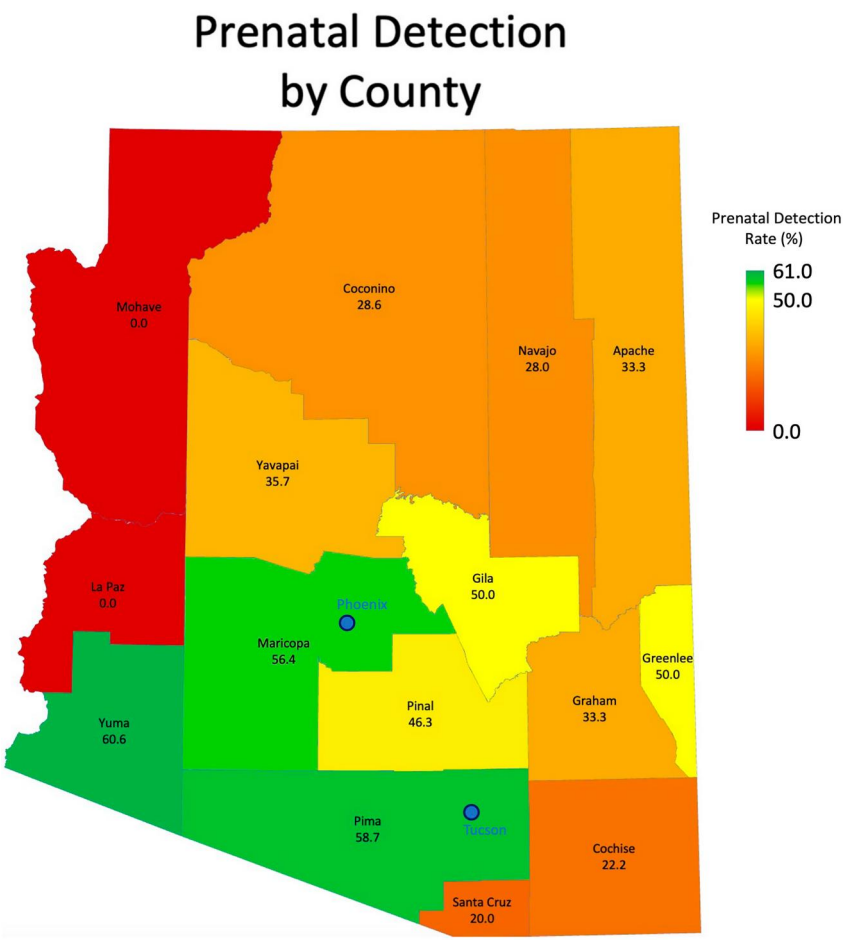

FIGURE 1 Heat map with the prenatal detection rate for each county. Yellow indicates a detection rate of 50%, which is about the national average with red indicating worse detection and green indicating detection above average. The locations of Arizona's 2 largest metropolitan locations (Phoenix and Tucson) were included as a reference to more urban locations.

TABLE 3 Multivariable logistic model for prenatal detection rate.

Predictor	Comparison groups	Difference	95% CI		*p*-value
Insurance	Public versus private	−0.07	−0.137	−0.009	0.0250
Ethnicity	Native American versus Non-Native American	−0.08	−0.202	0.037	0.1759
RUCA score	Urban versus rural	+0.14	0.041	0.243	0.0060

Note: When controlling for sociodemographic variables using a multivariable logistic model both insurance and RUCA score were independent predictors of PDR. Ethnicity however was not an independent predictor, indicating the statistical significance was likely due to overlapping of these groups.

Abbreviations: PDR, prenatal detection rate; RUCA, rural-urban commuting area.

(60.6%). Prenatal detection rate was the highest for diagnoses most likely detected in the 4-chamber view (80.0%) followed by the outflow tract view (64.7%) and then the 3-vessel/arch view (44.0%) as shown in Figure 3.

3.4 | Outcome variables

3.4.1 | Mortality

The overall mortality rate was 3.5% (35/1008 patients) for all cases over the course of the study. The mortality rate for those with a PND was 4.9% (26/533 patients), which was significantly higher than that for those without a PND of 1.9% (9/475 patients, *p*-value 0.01).

3.4.2 | Perinatal outcomes

Apgar scores assigned at 1 and 5 min of life did not show any statistical difference whether there was a PND or not (1-/5-min scores were 7.31/8.34 without prenatal detection vs. 7.49/8.31 with PND, *p*-value 0.61). Initial lactate values were reported only for 260 patients but did not show a significant difference (3.55 vs. 2.83, *p*-value 0.69). Initial pH also did not differ (7.3 vs. 7.3, *p*-value 0.6), with 354 values reported.

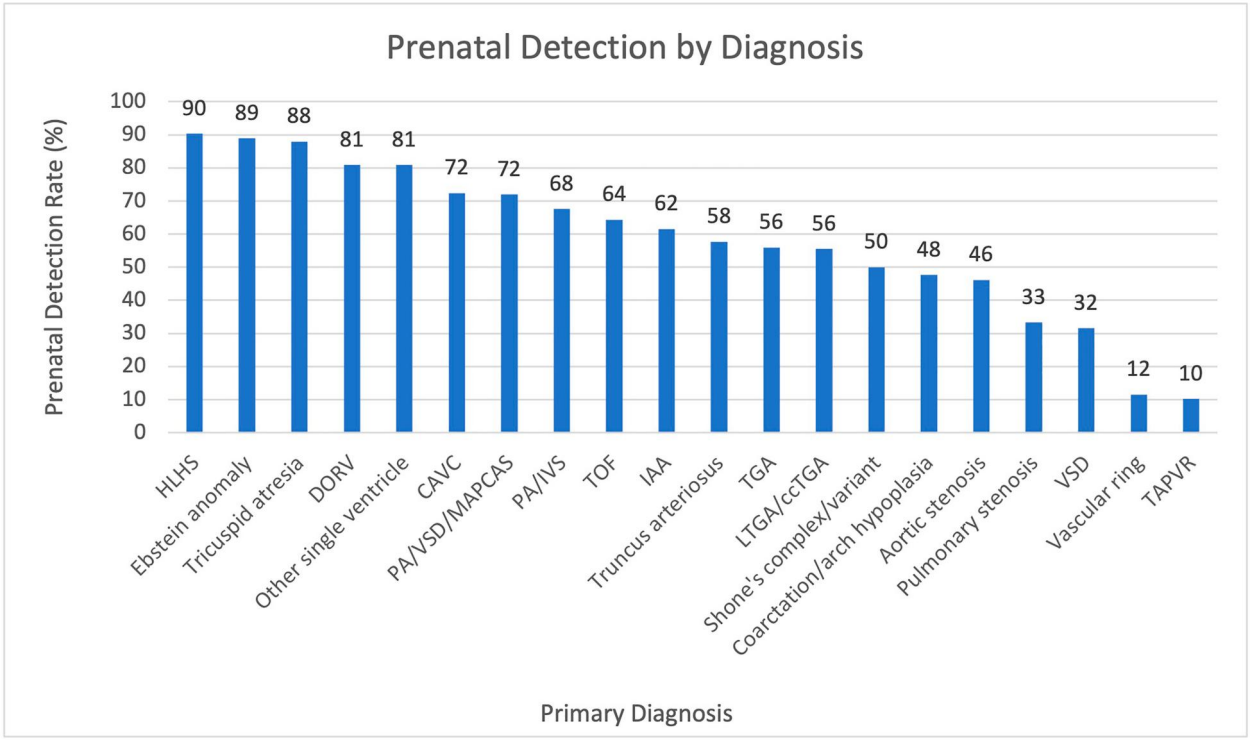

FIGURE 2 Graph showing the prenatal detection rate of various cardiac diagnoses in descending order. ASD, atrial septal defect; AVC, atrioventricular canal; DORV, double outlet right ventricle; HLHS, hypoplastic left heart syndrome; PA/IVS, pulmonary atresia with intact ventricular septum; PA/VSD/MAPCAs, pulmonary atresia with ventricular septal defect and major aortopulmonary collateral arteries; TGA, transposition of the great arteries; VSD, ventricular septal defect.

3.4.3 | Time to surgery

The age at the time of surgery was lower in patients with a PND as compared to those without (2.6 vs. 3.76 months, p-value <0.0001). When specifically looking at D-TGA and HLHS, the time to surgery was significantly less in those with a PND (12 vs. 20 days, p-value 0.0071).

4 | DISCUSSION

4.1 | Prenatal detection rate

Our overall PDR of CHD was 58%, which is very similar to previous studies. Quartermain et al. used the same STS-Database (although this did not include fetal demise/termination cases), collecting national data from 2006 to 2012 and reported a national PDR of 34%. They noted an improving detection rate each year of their study (initial detection rate of 26% which increased to 42% in 2012). Arizona was one of the states with the highest prenatal detection rates (estimated between 40% and 50%). Our patient cohort included data immediately after this, examining patients from 2013 to 2018. The initial PDR was 49.4%, which falls in line with the previously reported detection rate. We likewise saw an improving detection rate over the course of our study, with the final year having a 67% detection rate (Figure 4). Of note the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) updated their fetal cardiac screening guidelines in 2013 to include imaging of the outflow tracts, in addition to the previously recommended 4-chamber view. Our improved PDR compared to previous studies is likely a result of the implementation of this guideline.

Interestingly, we noted that the improvement in PDR over the course of this study was largely driven by increased detection in the urban population (Figure 4). Detection rates progressively improved in this population over the 5-year period by an average of 3% per year (p = 0.0007). Meanwhile, this was not reflected in the rural population, which showed no improvement over time (p = 0.6162, Figure 4). The difference between improvement rates between these groups was statistically significant with a p-value of 0.02. This further emphasizes the disparity between rural and urban populations and highlights a focal point for future interventions. Our study demonstrates higher PDR in high-risk pregnancies. It is standard practice that these patients receive a fetal echocardiogram (instead of just the anatomy scan ultrasound) and have an increased number of surveillance ultrasounds, which may explain their improved PDR. This also suggests that efforts to improve the detection rate in low-risk pregnancies may create more impact on the overall PDR. Therefore, future interventions involving fetal cardiac screening education and raising medical provider awareness on the risk of fetal cardiac disease will target this low-risk pregnancy population. This study will hopefully raise awareness and identify gaps where further education and training could play a role in improving detection rates.

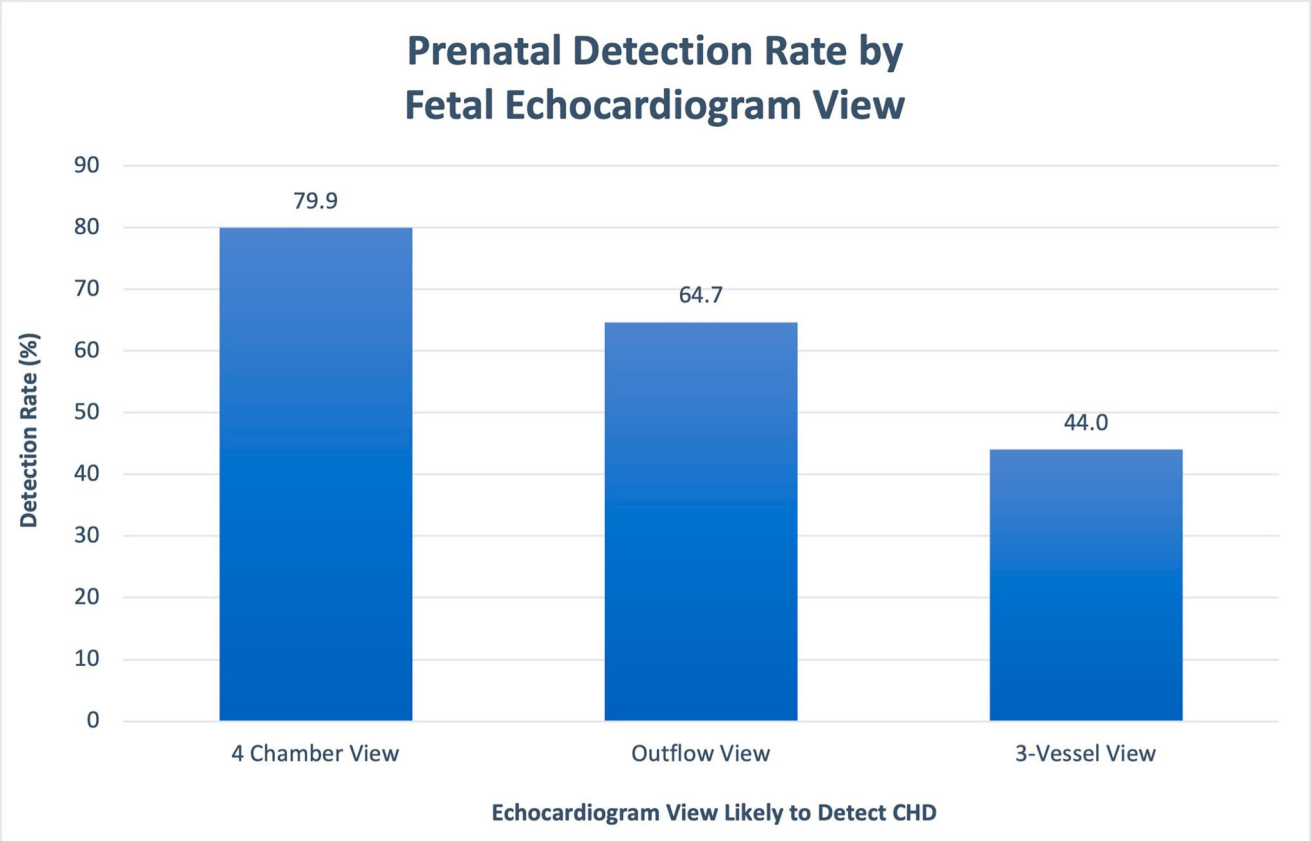

FIGURE 3 The prenatal detection rate of cardiac disease divided into which fetal echocardiogram view was most likely to detect each cardiac diagnosis (previously defined by Hill et al.).[12] Four chamber view = hypoplastic left heart, tricuspid atresia, Atrioventricular canal defect, Pulmonary atresia with intact ventricular septum, Ebstein's anomaly, cardiac tumor, and other single ventricle variants. Outflow view = Tetralogy of Fallot, Truncus arteriosus, transposition of the great arteries, double outlet right ventricle, pulmonary stenosis, aortic stenosis. Three vessel view = Coarctation of the aorta, interrupted aortic arch, vascular ring.

4.2 | Sociodemographics

Our study determined several factors that were associated with a lower PDR, including rural residence, public insurance, and Native American ethnicity. When controlling for other variables using the multivariable logistic model, we found that insurance type and RUCA score were independent predictors of PDR while ethnicity was not. This is likely explained by the fact that a large percentage of Native American patients also had public insurance or lived in rural communities. One hypothesis for the lower detection rate in these populations is limited access to resources/healthcare, training, and education services. Several studies have shown that the creation of public health directives with universal prenatal obstetrical cardiac screening protocols improved rates of prenatal detection, especially those in rural areas. The Netherlands implemented a national screening program in 2007 which included obtaining both 4 chamber and outflow tract views, which saw prenatal detection rates improve from 35.8% to 59.7%.[13] More recently in 2022 in Guangdong, China, Chen et al. added a 3-vessel view to the above screening protocol and saw their detection rate for major CHD reach 70%.[14] In both studies a tertiary center provided education and training to sonographers and physicians regarding the diagnosis and counseling of CHD at satellite sites.

4.3 | Outcomes

Prenatal detection was not associated with improved patient perinatal outcomes in this study—in fact, the mortality rate was significantly higher in patients with a PND. This relationship has been demonstrated previously and is likely explained by the fact that more severe heart disease as well as concurrent genetic abnormalities have higher prenatal detection rates. A sensitivity analysis removing single ventricle variants from our data demonstrated that the mortality difference was no longer significant, which supports this theory. Additionally, we did not find any significant difference in Apgar scores, initial pH, or initial lactate levels. The initial pH and lactate levels were difficult to assess as there were multiple birthing centers and no standard protocol to obtain them. Current data are mixed as regards the benefit of a PND in patient outcomes.[4–7,11,15–17] Our study focused on immediate postnatal outcomes; however, previous studies have demonstrated the benefit of a PND over the entire pre-

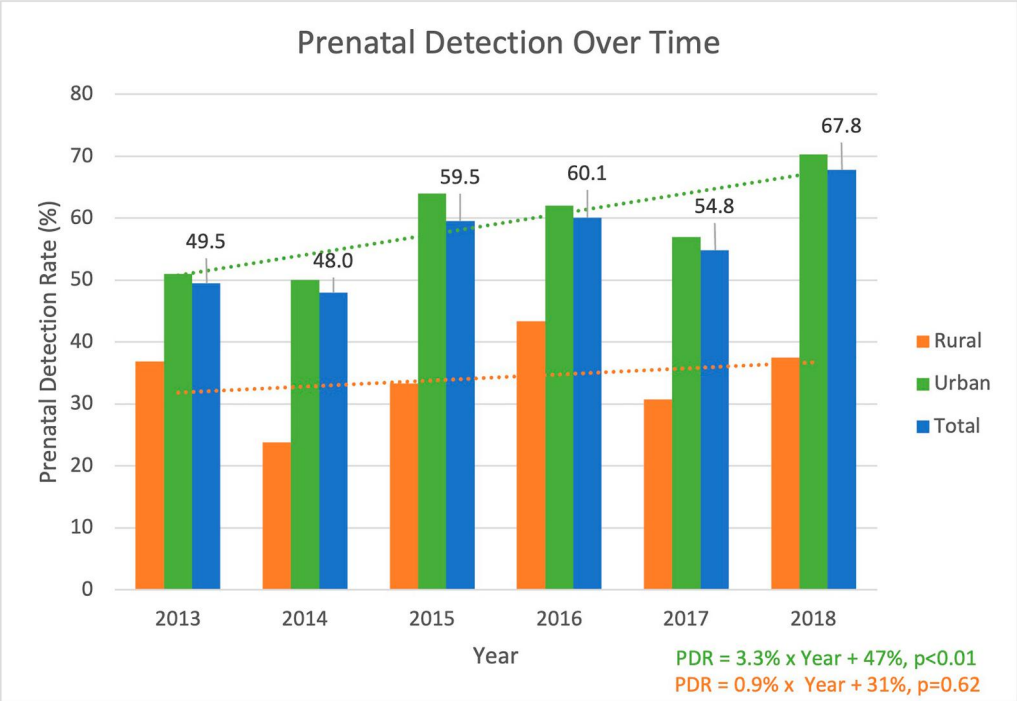

FIGURE 4 The prenatal detection rate over time, giving the total detection rate as well as separating rural and urban populations. The associated line of best fit indicates that the PDR improved for the urban population by 3.3% per year; however, this pattern was not reflected in the rural population. PDR, prenatal detection rate.

operative time period. Our data suggest that this improved morbidity is likely not related to the initial resuscitation efforts after birth but rather the subsequent time period prior to surgery.

The time to surgery was shorter for infants with a PND of CHD. This is partly due to higher detection rates of critical CHD that require earlier intervention by nature of more severe disease. However, when examining only those patients with HLHS and D-TGA (lesions selected for younger age for postnatal intervention), it is notable that the time to surgery was significantly shorter in the prenatally diagnosed group. The pre-operative time period is often marked by significant hemodynamic instability which can, in turn, have a detrimental impact on perioperative outcomes. Minimizing this time frame may be a significant advantage of fetal diagnosis.

4.4 | Fetal echocardiogram views

Analyzing cardiac diagnoses by groups, single ventricle variants had the highest detection rate (84%), followed by atrioventricular canal defects (72.4%), conotruncal defects (60.6%), and all other defects (43.3%). This correlates very closely with the fetal echocardiographic view expected to detect each type of abnormality. Those with an abnormal 4-chamber view had a detection rate of 80%, while defects with an abnormal outflow tract view had a PDR of 64.7% and 3-vessel view had a PDR of 44% (Figure 3). Previous studies have shown similar results,[6,9,18,19] emphasizing the need to focus on the outflow tract and 3-vessel views during cardiac screening. These views can be more challenging to obtain, and lack of technical expertise and variations in adherence to the updates ISUOG guidelines may explain part of the lower PDR. Proper, routine acquisition of these views can help identify a number of critical congenital heart defects and significantly impact the perinatal management of the fetus. For example, a critical coarctation of the aorta can be identified in the 3-vessel view but may be challenging to diagnose in other views. Further efforts into improved sonographer and physician education and hands-on training would address these current barriers to detection.

4.5 | Limitations

This study had several limitations. First and foremost, the true PDR of CHD will never be attainable as there are patients who die prior to care or who never present to a healthcare facility. Here, we attempted to provide the best estimate possible by including all available groups, including intrauterine fetal demise, stillbirths, and terminations. Notably, previous studies do not always include these populations, and as such our prenatal detection rates are higher than some previously reported. Similarly, there are minor congenital cardiac defects (for example a small VSD) and whether it was detected prenatally or not was not included in this study as they would not have had surgery within the first year of life. By doing so, we focused on the prenatal detection of major cardiac lesions. Phoenix Children's performs a vast majority of congenital cardiac surgeries in Arizona

and is the only center reporting to STS during this time. Our data is the best representation of PDR of CHD requiring surgical intervention in the state of Arizona; however, it does not include smaller volume surgical centers. If a fetal diagnosis was made but the patient did not have cardiac intervention at our center, this data was not able to be captured. Approximately 6% of mothers received no or insufficient prenatal care, which was considered the same as a missed diagnosis for patients who did have prenatal care. This was acceptable for our study as our primary goal was to identify missed cases to design successful future interventions. However, when running advanced analysis, it was difficult to separate these two groups. The retrospective nature of our review limits the translatability of our data to current practices; however, the factors associated with lower and higher PDR do provide a foundation for future interventions. While performing chart reviews from multiple outside delivery centers, there were also varying degrees of documentation with some missing data for certain patients.

4.6 | Future directions

This study helps define the current factors associated with prenatal detection of CHD. Future efforts should aim to provide targeted education and training, especially in areas with limited resources such as rural communities and areas with a high concentration of publicly insured patients. There may be a role for telemedicine in these regions as well. As telemedicine has become more integrated into our practices, it may provide a way to optimize resources and deliver high-quality care to rural areas. Diagnoses primarily seen in the outflow tract and 3 vessel views showed lower prenatal detection rates, and continuing implementation of previous guidelines to include these views should continue to improve detection rates.

5 | CONCLUSION

The aims of this study were to provide updated prenatal detection rates of CHD as well as to determine variables that may impact that rate. Our data show an overall PDR of 58% and an incremental improvement over the course of the study with a PDR of 67% in 2018 as a result of improved detection in urban communities. We also highlight the lower prenatal detection rates for those in rural areas, Native Americans, or who have public insurance with the goal of increasing efforts for improving detection and access to care in these populations going forward. Classification of the fetal cardiac views of missed diagnoses provides further evidence to target education and implementation of obstetrical cardiac screening guidelines.

ACKNOWLEDGMENTS

We would like to acknowledge Hamy Temkit, PhD for providing the multitude of statistical calculations and insights for this project. Additionally, Maryam Gilpatrick, MD and Sarah Auran, MD were both heavily involved in the data collection process. There were no sources of funding associated with the findings in this paper or any of the authors involved.

CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest to report. The COI policy was reviewed with all the authors prior to submission for publication.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available for privacy reasons.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Mattia D., Matney C., Loeb S., et al. Prenatal detection of congenital heart disease: recent experience across the state of Arizona. *Prenat Diagn*. 2023;1-10. https://doi.org/10.1002/pd.6409