

Neighborhood Deprivation and Risk of Gestational Diabetes Mellitus in Arizona



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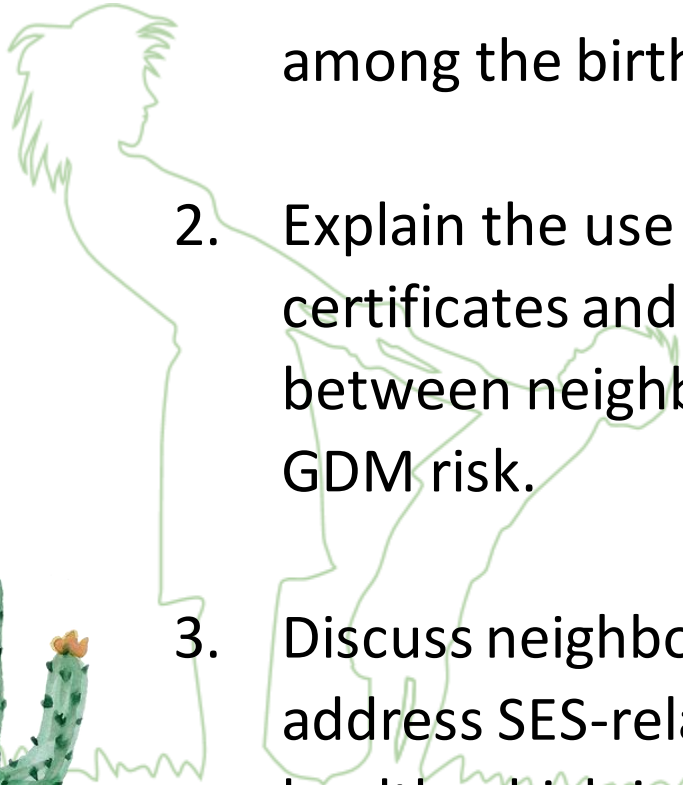
Harvard T.H. Chan School of Public Health

LAND ACKNOWLEDGMENT

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally-recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

Learning Objectives

1. Describe the role of neighborhood deprivation on GDM risk among the birthing population in Arizona.
2. Explain the use of secondary data (i.e., statewide birth certificates and US Census Data) to understand the relationship between neighborhood deprivation, a nonmodifiable factor, and GDM risk.
3. Discuss neighborhood deprivation and potential strategies to address SES-related systemic issues and social determinants of health which influence GDM risk.



Gestational Diabetes Mellitus (GDM)

Glucose intolerance disorder during pregnancy (ACOG et al., 2018)

- Diagnosed during pregnancy at 24-28 weeks

GDM has been rising worldwide and nationally (Gregory et al., *Natl Vital Stat Rep*, 2022)

- 7.8 cases of GDM per 100 births in 2020
- GDM increased substantially approx. 30% from 2016 to 2020



Maternal health crisis

Mothers with GDM are the most at-risk group for Type 2 diabetes

8.3-fold increase in risk

Type 2 diabetes is one of the leading causes of premature and preventable death and disability in the USA

Ethnic groups are the most at-risk for GDM

Dennison et al., *DRCP*, 2020.

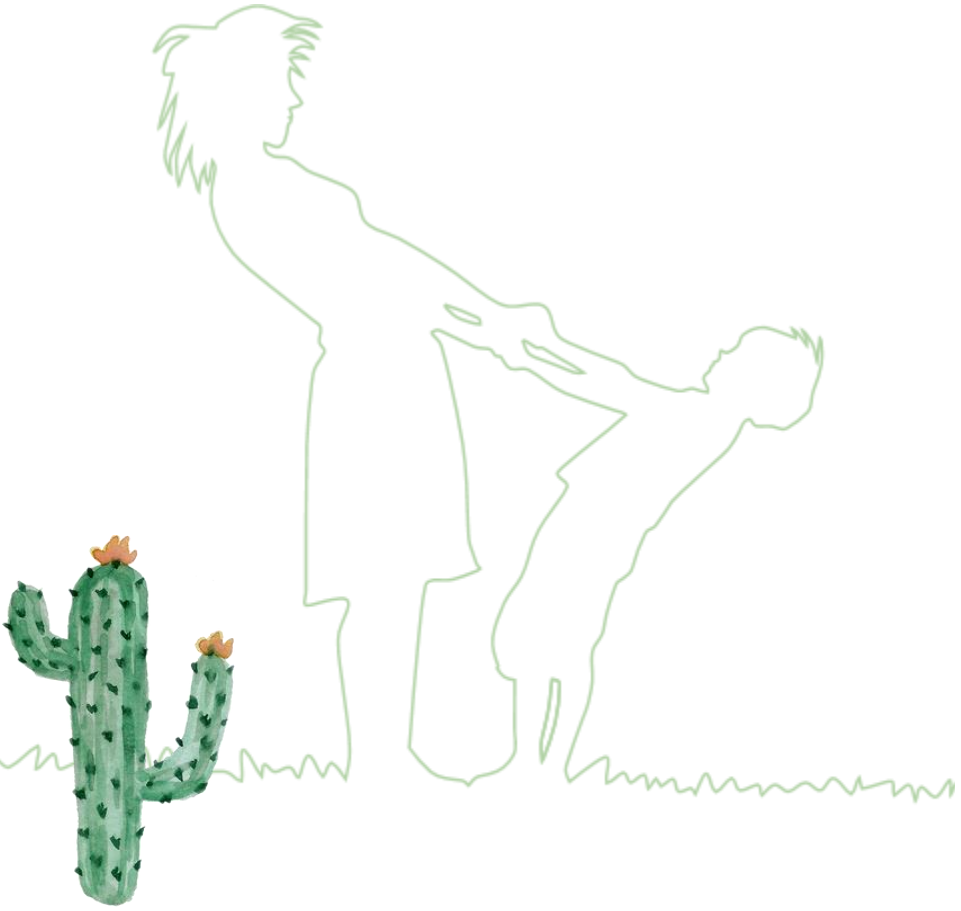
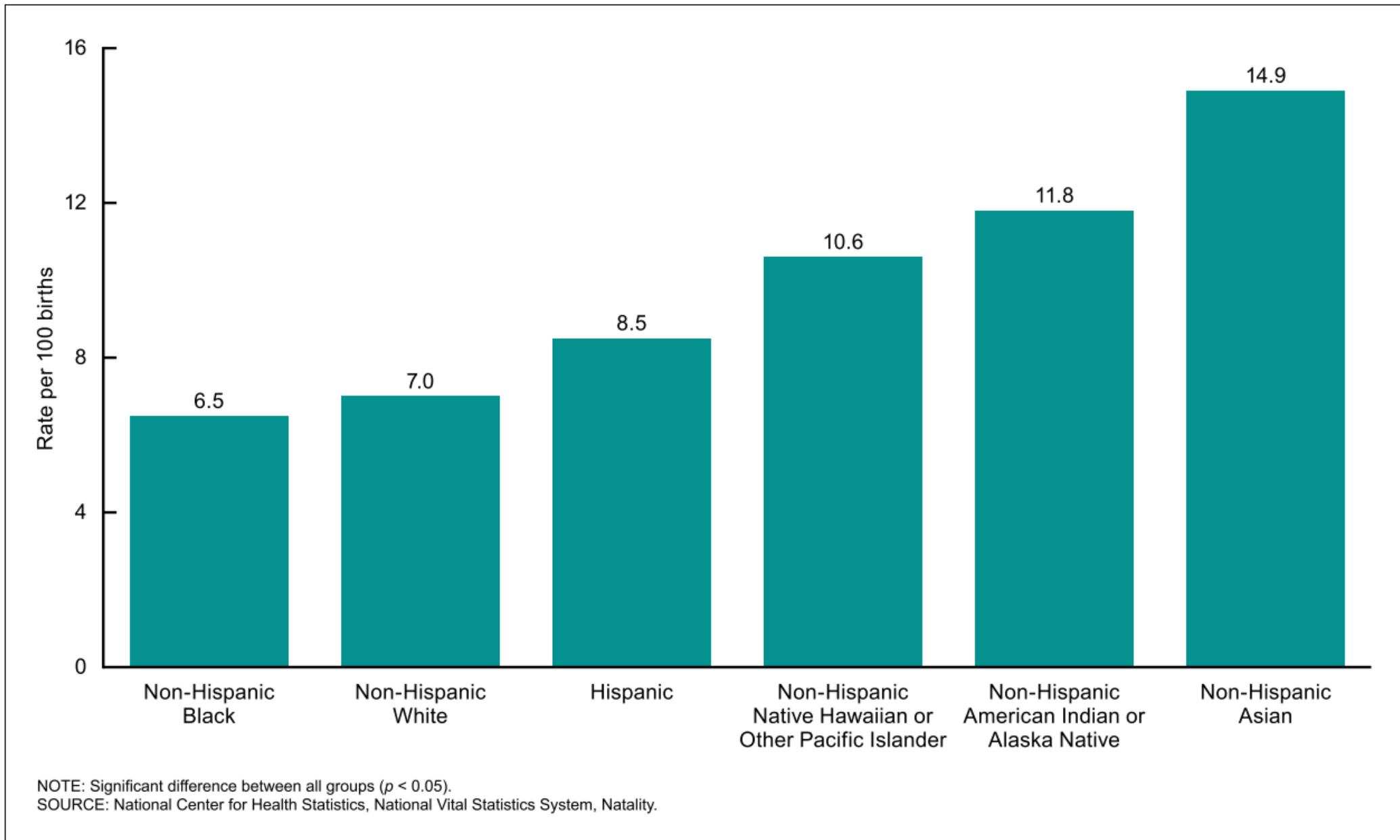


Figure 2. Rate of gestational diabetes, by race and Hispanic origin of mother: United States, 2020

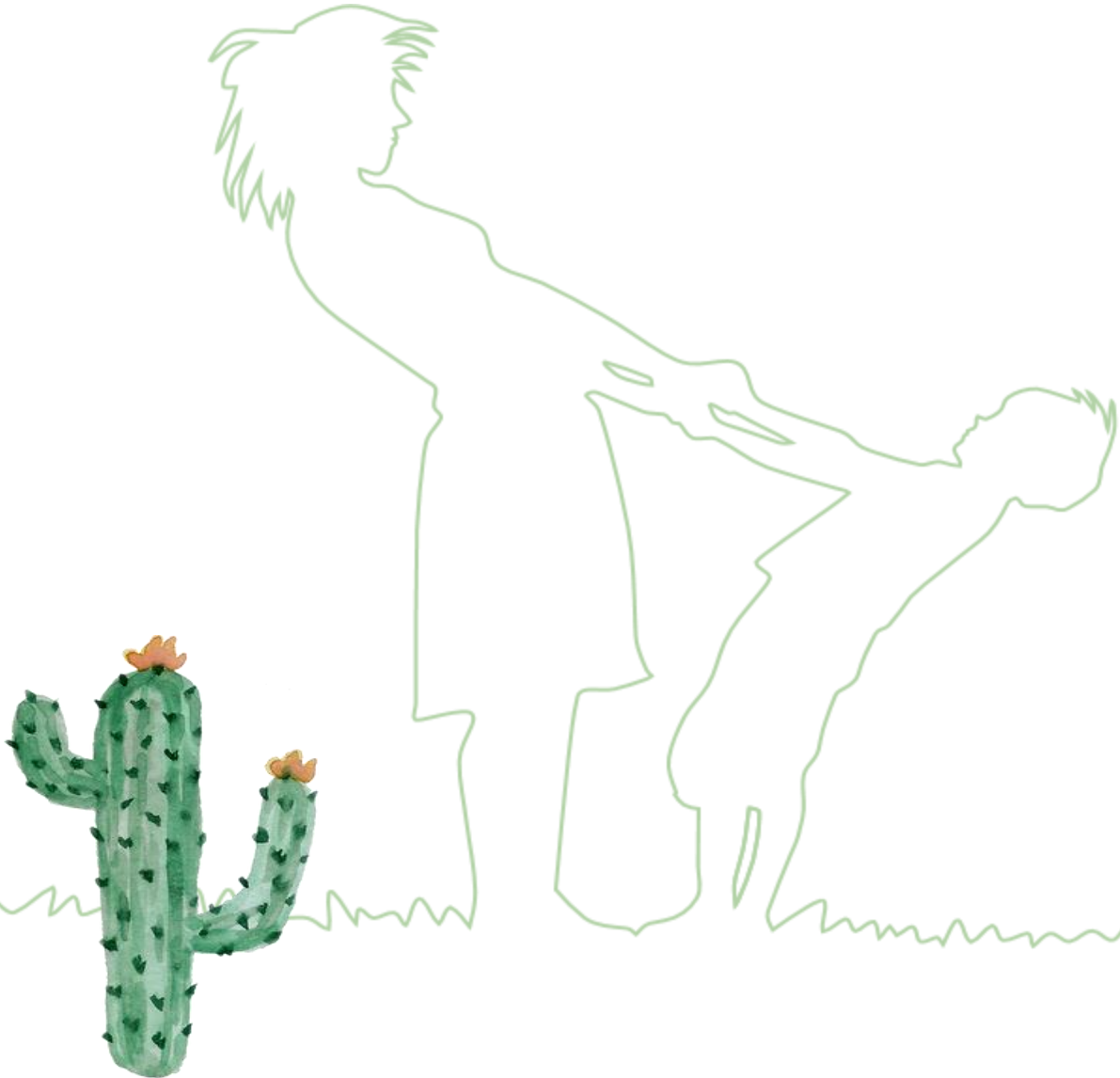


Individual-level factors do not fully account for GDM risk

Zhang et al., *Diabetologia*, 2016.



Neighborhood Deprivation



Social and economic disadvantages – such as unemployment, poor housing quality, high crime, and low educational attainment – in a geographically bounded area

MATERNAL STRESSORS

Living in a deprived neighborhood can negatively influence the health trajectory of pregnant mothers increased risk for cardiometabolic risk factors post-pregnancy (Kramer et al., *Ann Behav Med*, 2014).

Chronic stress among mothers of low-social status is attributed to neighborhood deprivation (Steptoe et al., *Ann Behav Med*, 2010).



OBJECTIVE



To characterize the risk of gestational diabetes from neighborhood deprivation in Arizona.



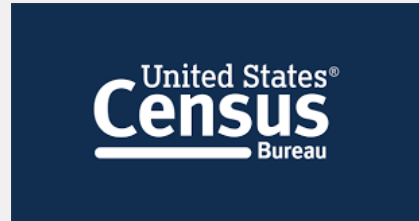
AZPEARS Study: Arizona Prenatal Environment And Reproductive Outcomes Study



ARIZONA DEPARTMENT
OF HEALTH SERVICES



**Birth
Certificates**



**US Census
2010**



**Pesticide
Use
Reports**

2003 US Birth Certificate revision (adopted in 2014)

LOCAL FILE NO.		U.S. 1	
CHILD		MOTHER	
1. CHILD'S NAME (First, Middle, Last, Suffix)		29a. DATE OF FIRST PRENATAL CARE VISIT	29b. DATE OF LAST PRENATAL CARE VISIT
5. FACILITY NAME (If not institution, give street and number)		30. TOTAL NUMBER OF PRENATAL VISITS FOR THIS PREGNANCY	
MOTHER		31. MOTHER'S HEIGHT (feet/inches)	
8a. MOTHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)		32. MOTHER'S PREGNANCY WEIGHT (pounds)	
8c. MOTHER'S NAME PRIOR TO FIRST MARRIAGE		33. MOTHER'S WEIGHT AT DELIVERY (pounds)	
9a. RESIDENCE OF MOTHER-STATE		34. DID MOTHER GET ANY FOOD FOR HERSELF DURING THIS PREGNANCY? <input type="checkbox"/> Yes <input type="checkbox"/> No	
9d. STREET AND NUMBER		35. NUMBER OF PREVIOUS LIVE BIRTHS (Do not include this one)	
FATHER		36. NUMBER OF OTHER PREGNANCY OUTCOMES (spontaneous or induced losses or ectopic pregnancies)	
CERTIFIER		37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY	
10a. FATHER'S CURRENT LEGAL NAME (First, Middle, Last, Suffix)		38. PRINCIPAL SOURCE OF PAYMENT FOR THIS DELIVERY	
MOTHER		39. DATE LAST NORMAL MENSES BEGAN	
11. CERTIFIER'S NAME		40. MOTHER'S MEDICAL RECORD NUMBER	
TITLE: <input type="checkbox"/> MD <input type="checkbox"/> DO <input type="checkbox"/> HOSPITAL ADMIN. <input type="checkbox"/> OTHER (Specify)		41. RISK FACTORS IN THIS PREGNANCY (Check all that apply)	
MOTHER		42. INFECTIONS PRESENT AND/OR TREATED DURING THIS PREGNANCY (Check all that apply)	
14. MOTHER'S MAILING ADDRESS: 9 Same as Street & Number		43. OBSTETRIC PROCEDURES (Check all that apply)	
15. MOTHER MARRIED? (At birth, conception, or if IF NO, HAS PATERNITY ACKNOWLEDGEMENT)		44. ONSET OF LABOR (Check all that apply)	
18. MOTHER'S SOCIAL SECURITY NUMBER		45. CHARACTERISTICS OF LABOR AND DELIVERY (Check all that apply)	
MOTHER		46. METHOD OF DELIVERY	
20. MOTHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)		47. MATERNAL MORBIDITY (Check all that apply)	
23. FATHER'S EDUCATION (Check the box that best describes the highest degree or level of school completed at the time of delivery)		48. NEWBORN MEDICAL RECORD NUMBER	
FATHER		49. BIRTHWEIGHT (grams preferred, specify unit)	
Mother's Name		50. OBSTETRIC ESTIMATE OF GESTATION (completed weeks)	
Mother's Medical Record No.		51. APGAR SCORE	
26. PLACE WHERE BIRTH OCCURRED (Check all that apply)		52. PLURALITY - Single, Twin, Triplet, etc. (Specify)	
28. IF NOT SINGLE BIRTH - Born First, Second, Third, etc. (Specify)		53. IF NOT SINGLE BIRTH - Born First, Second, Third, etc. (Specify)	
29. WAS INFANT TRANSFERRED WITHIN 24 HOURS OF DELIVERY? <input type="checkbox"/> Yes <input type="checkbox"/> No		54. ABNORMAL CONDITIONS OF THE NEWBORN (Check all that apply)	
IF YES, NAME OF FACILITY INFANT TRANSFERRED		55. CONGENITAL ANOMALIES OF THE NEWBORN (Check all that apply)	
37. IS INFANT LIVING AT TIME OF REPORT? <input type="checkbox"/> Yes <input type="checkbox"/> No		56. IS INFANT LIVING AT TIME OF REPORT? <input type="checkbox"/> Yes <input type="checkbox"/> No	
38. IS THE INFANT BEING BREASTFEED AT DISCHARGE? <input type="checkbox"/> Yes <input type="checkbox"/> No		57. IS THE INFANT BEING BREASTFEED AT DISCHARGE? <input type="checkbox"/> Yes <input type="checkbox"/> No	

41. RISK FACTORS IN THIS PREGNANCY
(Check all that apply)

Diabetes

- Prepregnancy (Diagnosis prior to this pregnancy)
- Gestational (Diagnosis in this pregnancy)

Hypertension

- Prepregnancy (Chronic)
- Gestational (PIH, preeclampsia)
- Eclampsia

- Previous preterm birth
- Other previous poor pregnancy outcome (Includes perinatal death, small-for-gestational age/intrauterine growth restricted birth)
- Pregnancy resulted from infertility treatment-If yes, check all that apply:
 - Fertility-enhancing drugs, Artificial insemination or Intrauterine insemination
 - Assisted reproductive technology (e.g., in vitro fertilization (IVF), gamete intrafallopian transfer (GIFT))
- Mother had a previous cesarean delivery
If yes, how many _____
- None of the above



Phoenix



Photo Credit: [Robyn Beck, AFP via Getty Images, 2023](#)

Tucson



Photo Credit: [Carol M. Highsmith, https://www.loc.gov/item/2018703695/](https://www.loc.gov/item/2018703695/)

Central Phoenix



Photo Credit: [Lindsay Robinson, Cronkite News, 2016](#)

Foothills Tucson

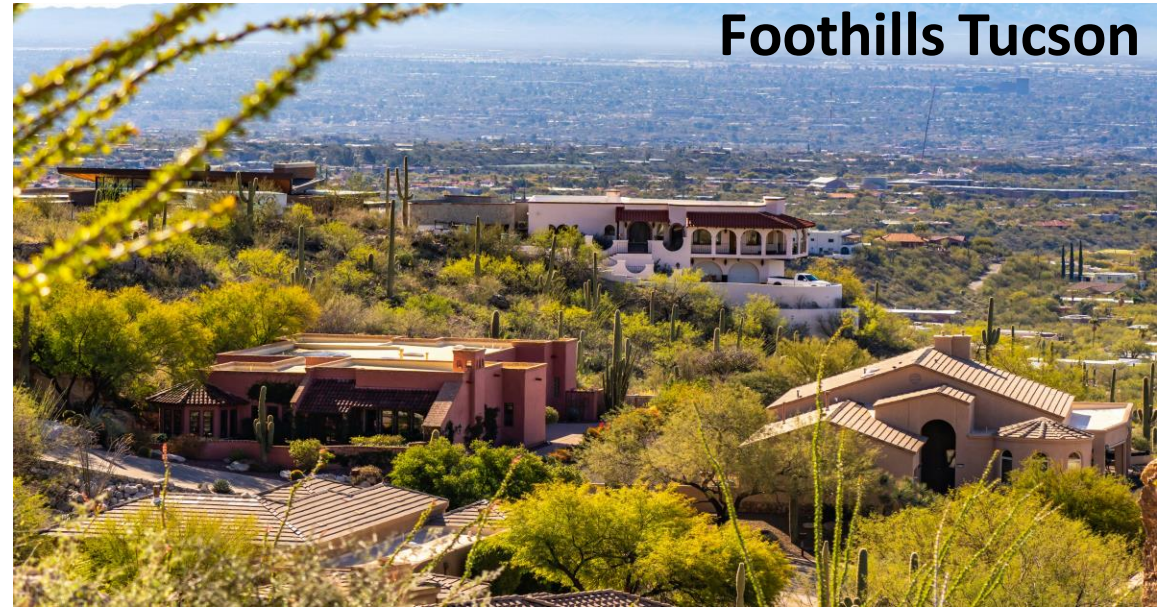


Photo Credit: [JC Cervantes on Unsplash](#)

Suburbs Phoenix



Photo Credit: [Berkshire Hathaway HomeServices Arizona Properties](#)

South Tucson



Photo Credit: [Kelly Presnell, Arizona Daily Star 2022.](#)

Yuma



Photo credit: [Luke Runyon, KUNC, 2021](#)

US-Mexico border (Nogales)

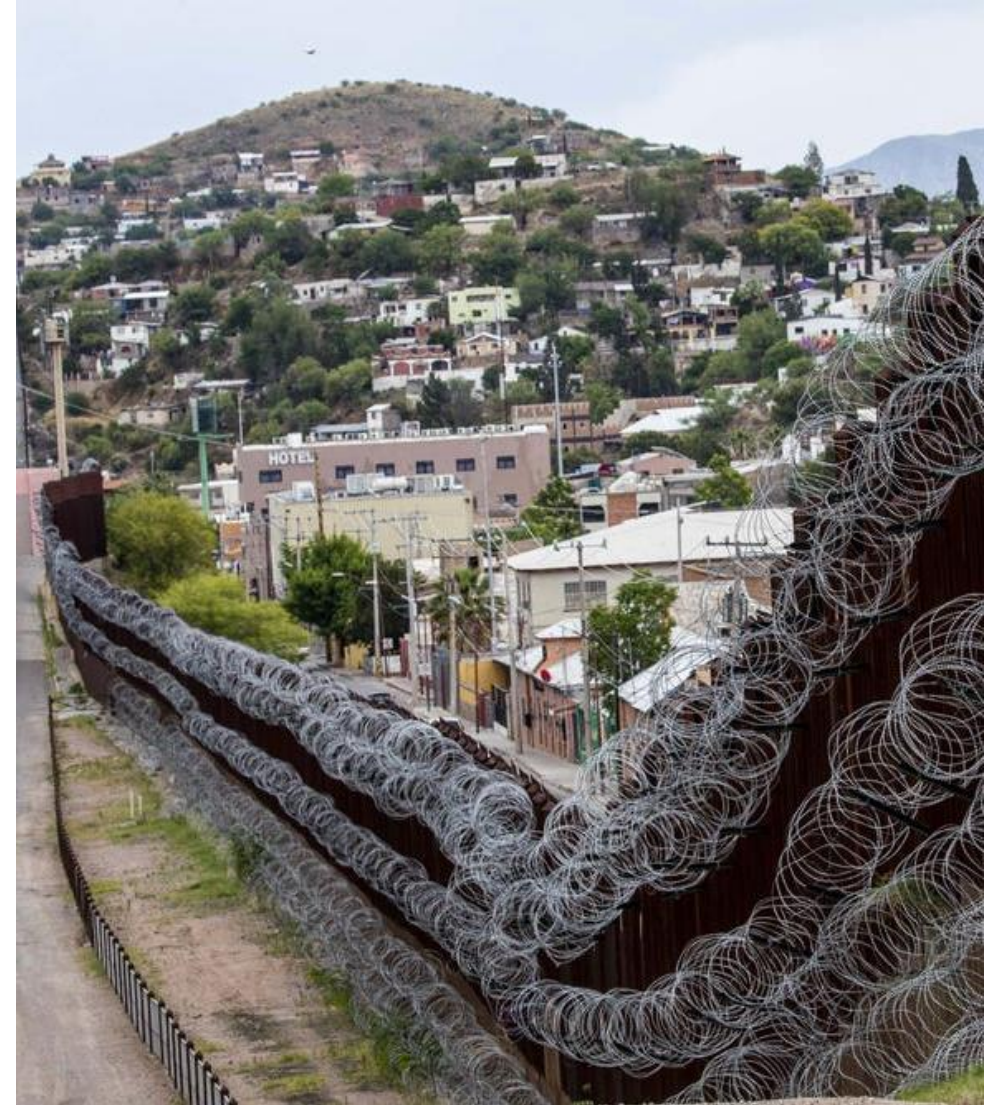


Photo Credit: [Rita Danks, The Arizona Republic, 2019](#)

Rural (Camp Verde)



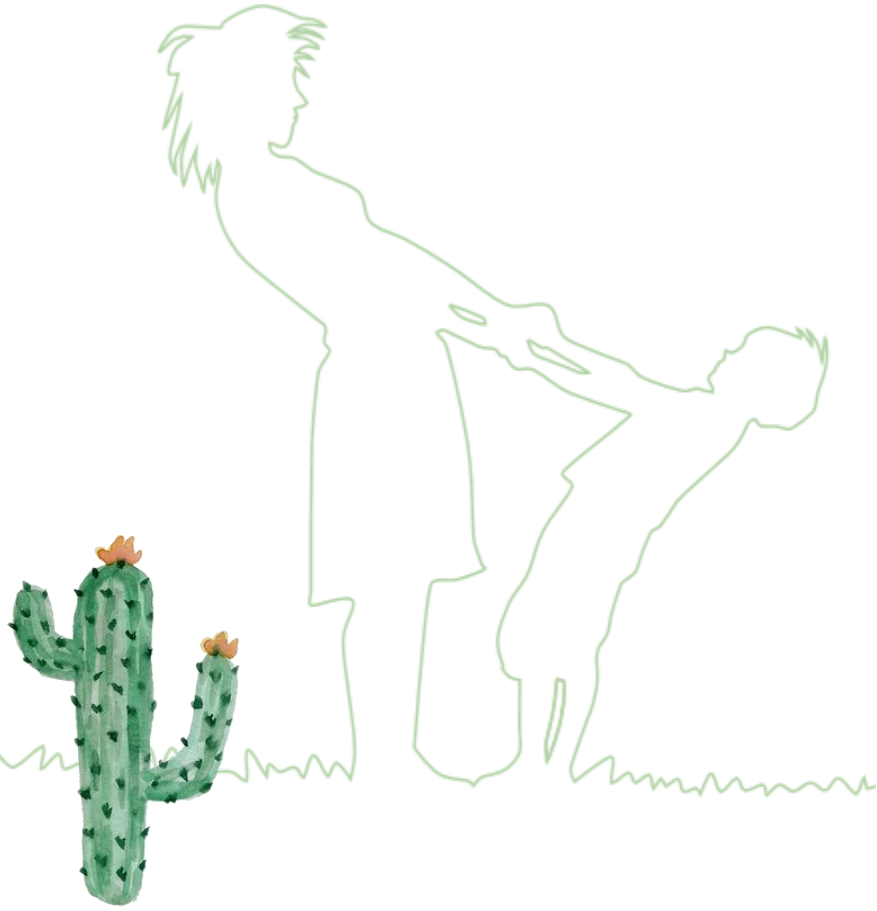
Photo Credit: [Unknown 2024](#)

Tribal Land (Navajo)



Photo Credit: [Carol M. Highsmith](#)

SELECTION OF DEPRIVATION INDEX

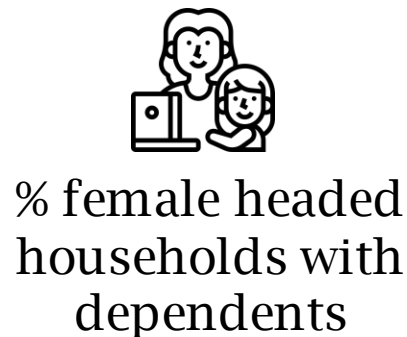
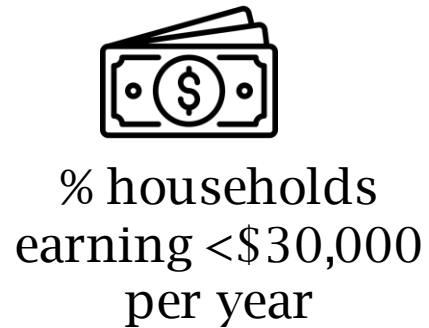
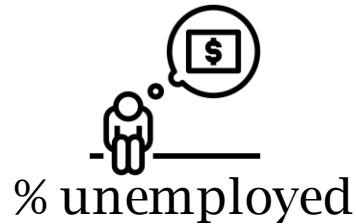


- 1) Neighborhood as the unit of analysis and implications for ecological bias.
- 2) Indicators used to measure poverty are relevant to the local context.
- 3) Potential interactions/collinearity with other individual-level variables during statistical analysis.
- 4) Validity for pregnancy and maternal health outcomes.

Neighborhood Deprivation Index (NDI)

Messer et al., *J Urban Health*, 2006.

A validated score that uses a weighted composite of eight census-based area-level economic parameters at the census tract level



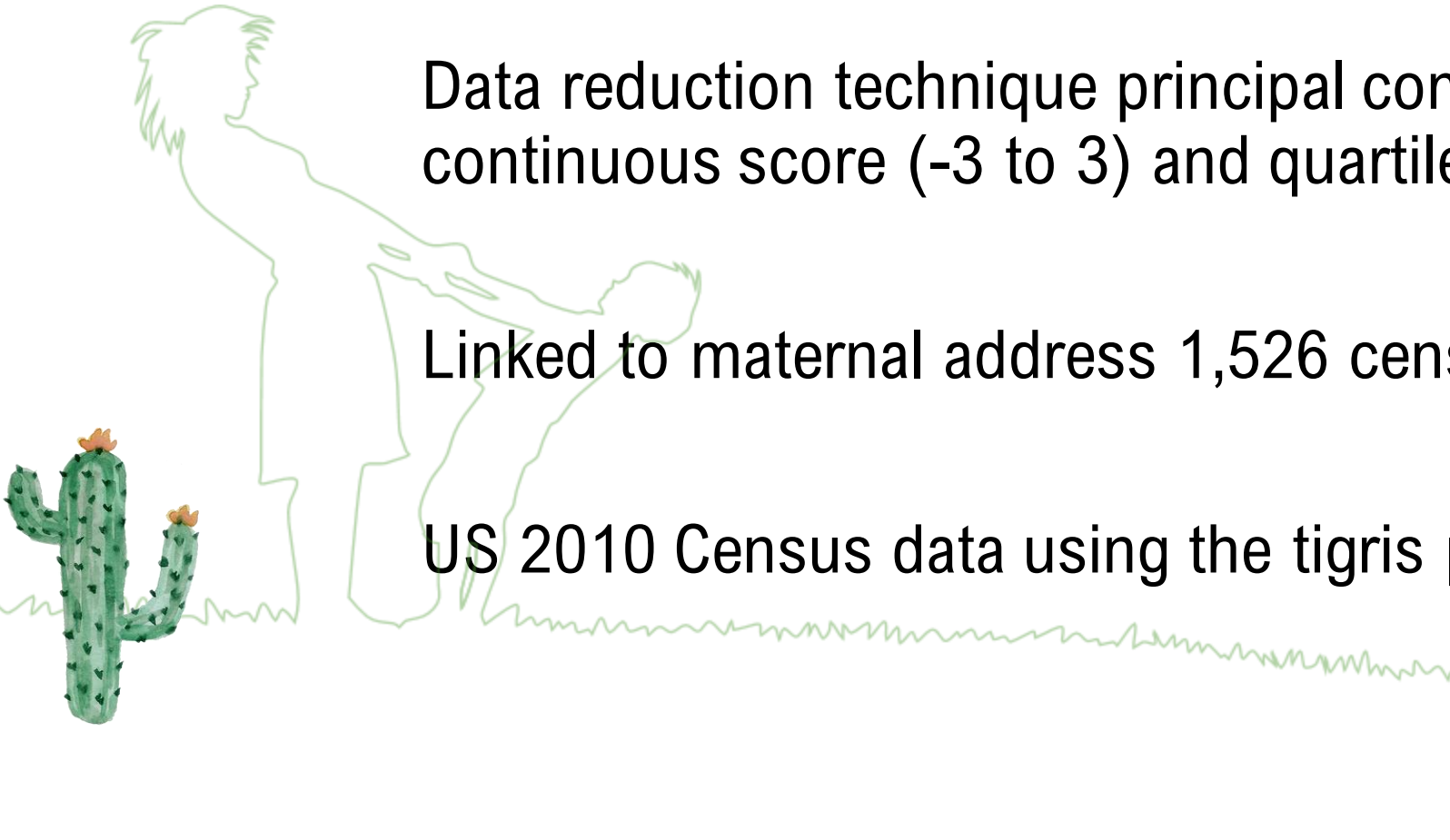
NEIGHBORHOOD DEPRIVATION INDEX

Calculated NDI by census tracts “neighborhoods”

Data reduction technique principal component analysis to create a continuous score (-3 to 3) and quartiles (Q1, Q2, Q3, Q4).

Linked to maternal address 1,526 census tracts within 15 counties

US 2010 Census data using the tigris package in R.



METHODS

Complete case analysis

n = 481,113

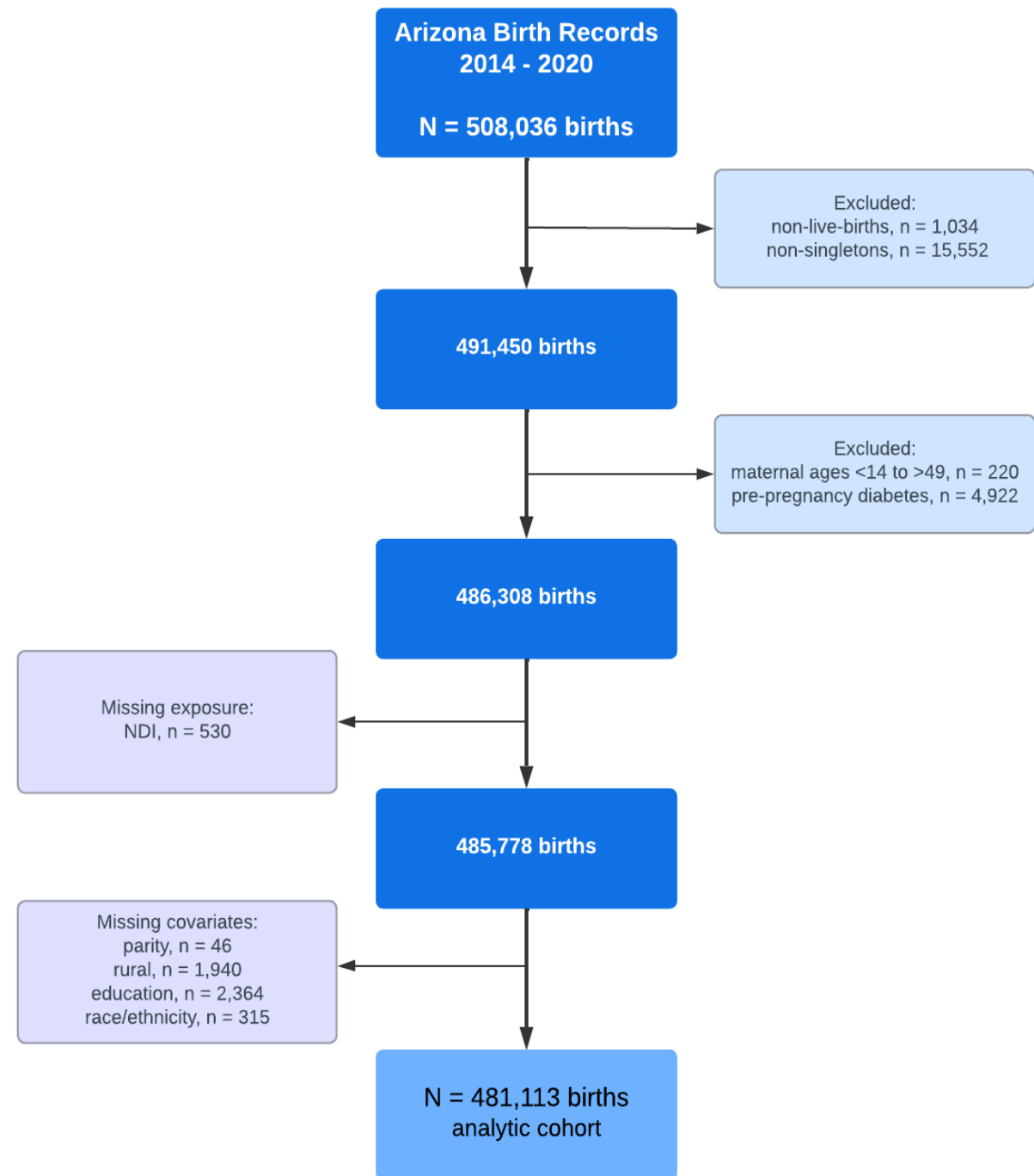
Covariate selection

Directed acyclic graph (DAG)
Adjusted for maternal age, education,
race/ethnicity, parity, rurality, and birth year.

Statistical analysis

Principal component analysis (PCA) to
compute neighborhood deprivation index
(NDI)

Multivariable log-binomial models (Risk
Ratios and 95% Confidence Intervals)



In this population based study,
the GDM **prevalence was 8%**
with areal differences ranging
from 4 to 12%.

GDM cases 37,636 (2014 to 2020)



Statewide incidence of
Gestational Diabetes Mellitus by
County in Arizona from
AzPEARS study (2014 to 2020)

County Name	GDM cases	Population	Incidence
Apache	377	2,668	12.4
Navajo	784	5,600	12.3
Coconino	770	7,470	9.3
Pinal	2,285	23,900	8.7
Pima	5,331	60,508	8.1
Yuma	1,195	13,783	8.0
Maricopa	24,778	292,893	7.8
Cochise	594	7,745	7.1
Greenlee	44	576	7.1
Graham	174	2,611	6.3
Gila	135	2,198	5.8
La Paz	50	834	5.7
Mohave	485	9,388	4.9
Yavapai	492	9,807	4.8
Santa Cruz	142	3,496	3.9

Results: Overall maternal population

28.6 years average maternal age

57% completed some college or higher

12% reported smoking before/during pregnancy

51% Medicaid recipients/AHCCCS



Results: GDM cases by NDI

NDI scores ranged from **-0.68 to 1.79**.

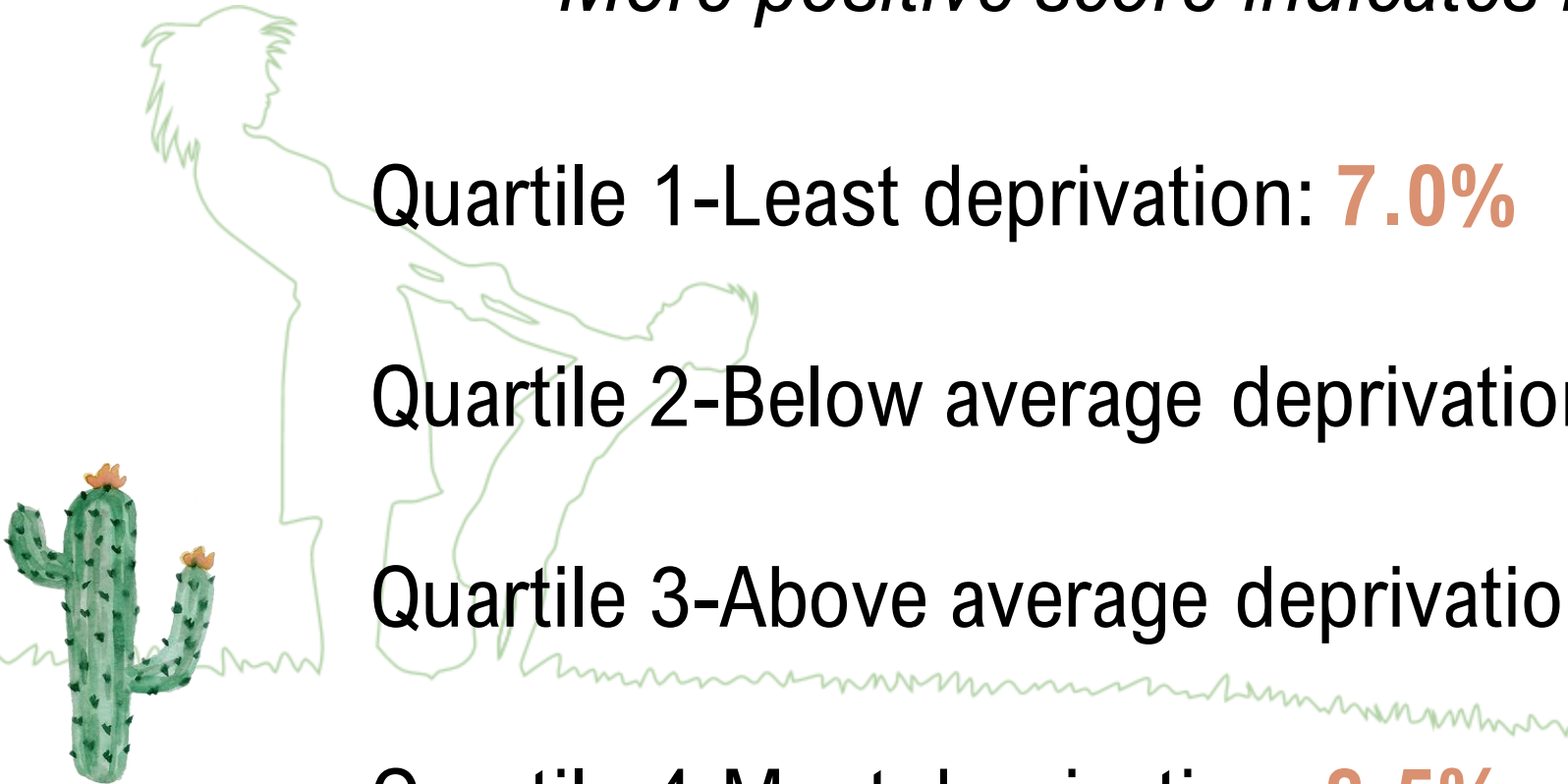
More positive score indicates more deprivation.

Quartile 1-Least deprivation: **7.0%**

Quartile 2-Below average deprivation: **7.7%**

Quartile 3-Above average deprivation: **7.7%**

Quartile 4-Most deprivation: **8.5%**



Results: NDI by Race/Ethnicity

Race/Ethnicity (n, %)	Q1 Least Deprivation	Q2 Below Avg Deprivation	Q3 Above Avg Deprivation	Q4 Most Deprivation	Total
Non-Hispanic White	59,315 (67.3)	70,039 (59.1)	54,549 (44.2)	25,202 (16.7)	209,105 (43.5)
Hispanic/Latina	17,931 (20.3)	34,772 (29.4)	53,718 (43.6)	100,301 (66.3)	206,722 (43.0)
NA/AI	819 (0.9)	2,584 (2.2)	4,163 (3.4)	12,189 (8.1)	19,755 (4.1)
Blacks	2,898 (3.3)	5,362 (4.5/21.0)	6,686 (5.4)	10,553 (7.0)	25,499 (5.3)
API	6,765 (7.7)	5,275 (4.5)	3,787 (3.1)	2,713 (1.8)	18,540 (3.8)
Other	436 (0.5)	402 (0.3)	361 (0.3)	293 (0.2)	1,492 (0.3)

Results: GDM vs. non-GDM

Older age: 31.3 vs. 28.4 years

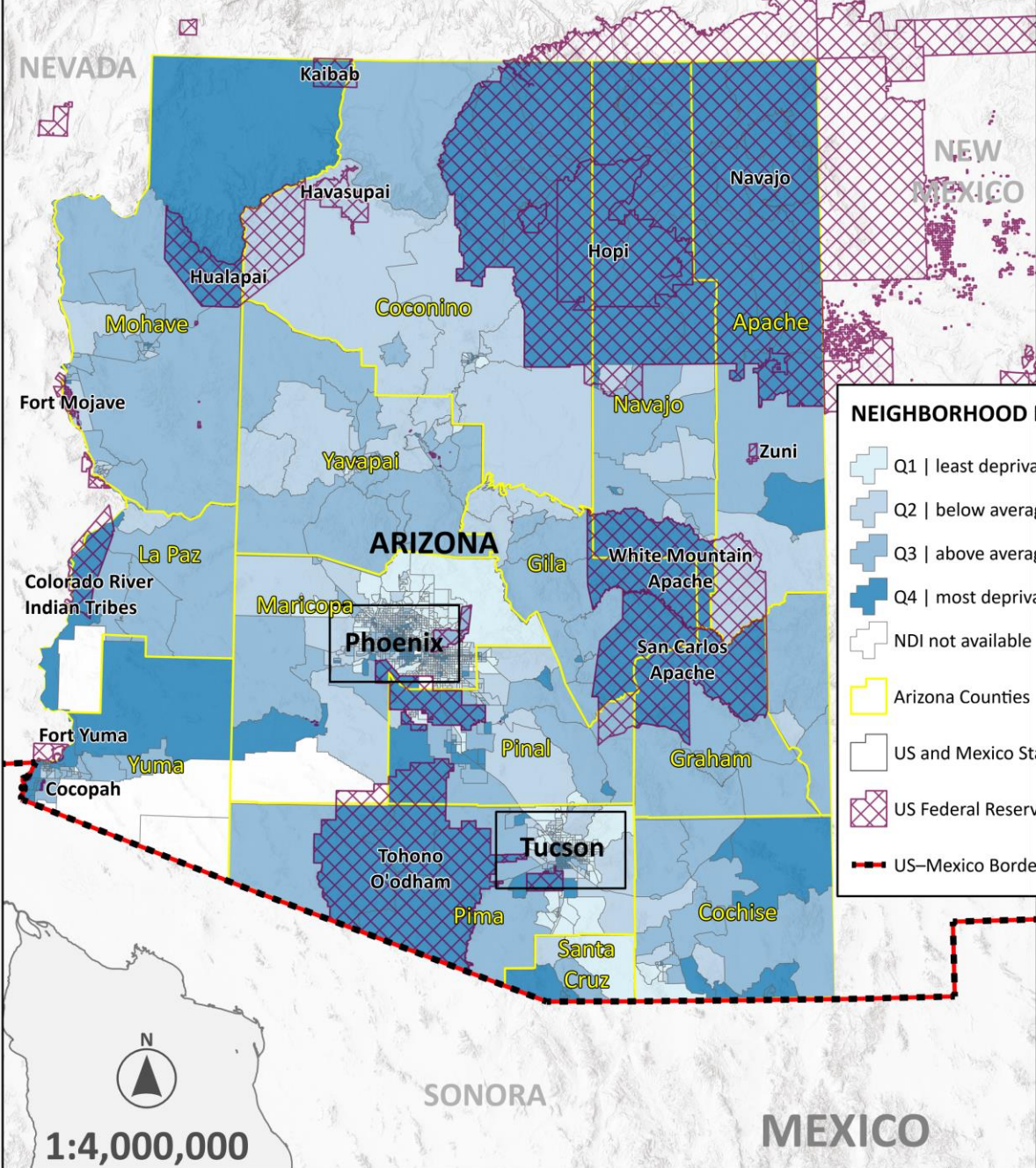
Obese: 49.3% vs. 24.8%

Multiparous >3 pregnancies

Larger neonates



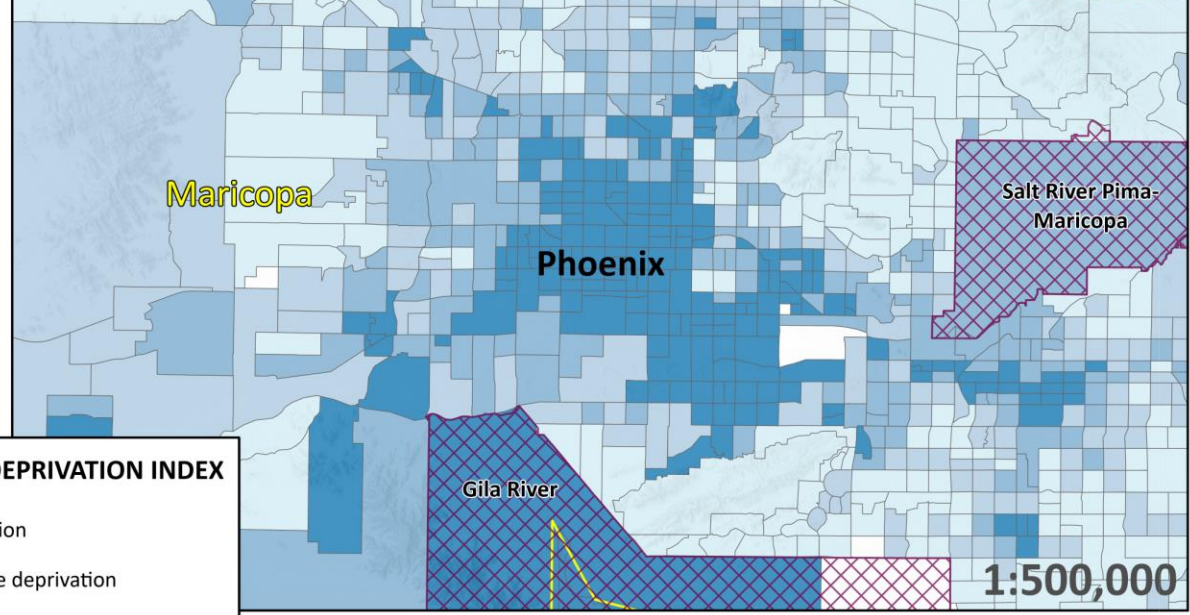
ARIZONA



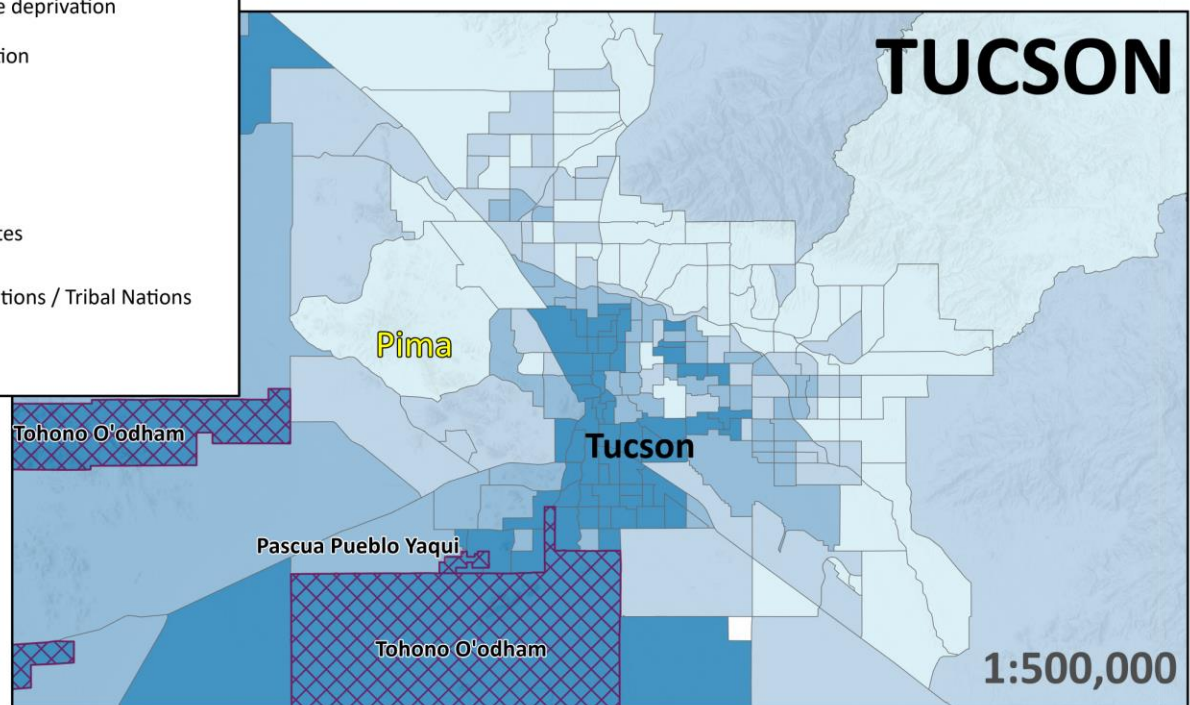
NEIGHBORHOOD DEPRIVATION INDEX

- Q1 | least deprivation
- Q2 | below average deprivation
- Q3 | above average deprivation
- Q4 | most deprivation
- NDI not available
- Arizona Counties
- US and Mexico States
- US Federal Reservations / Tribal Nations
- US-Mexico Border

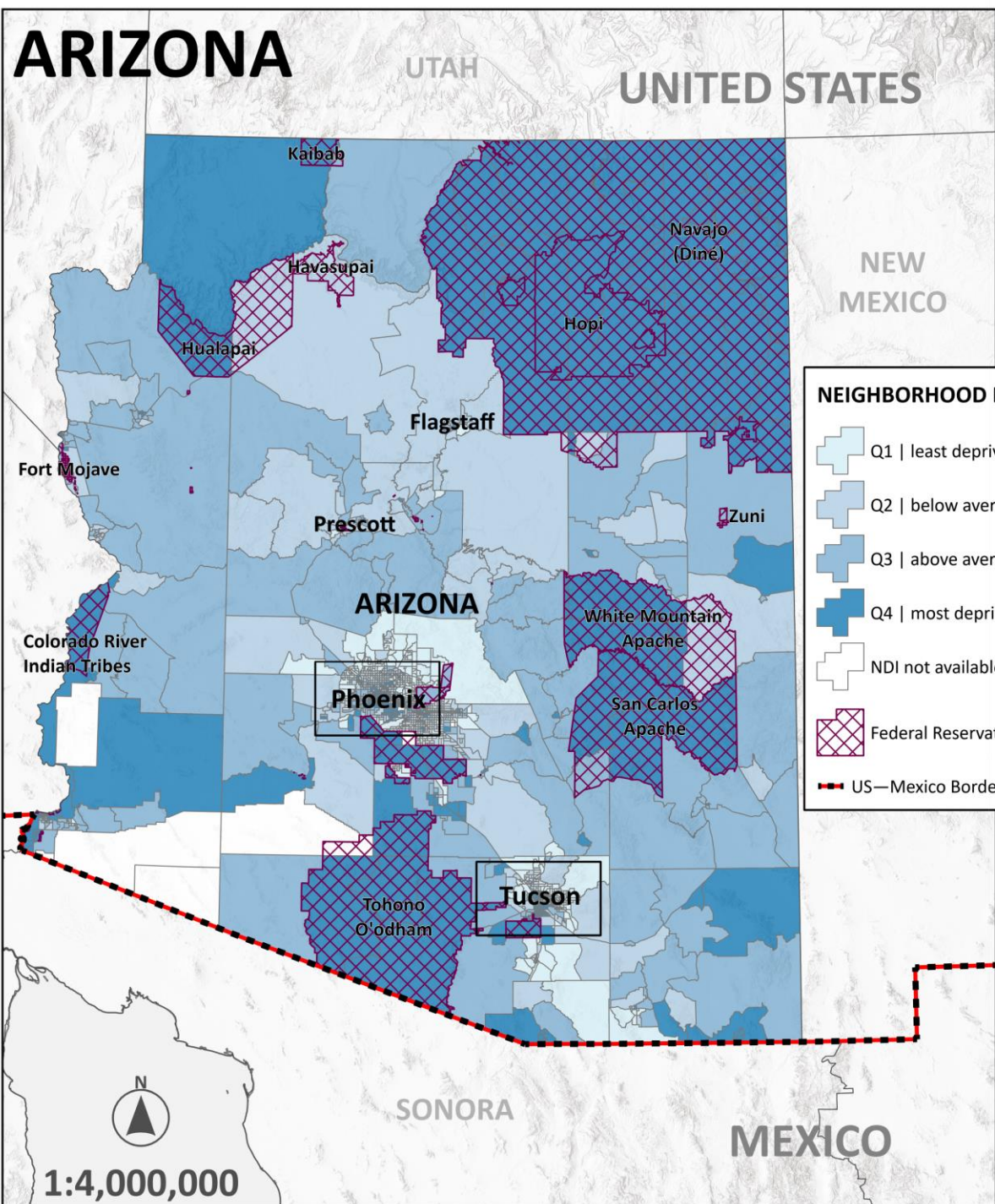
PHOENIX



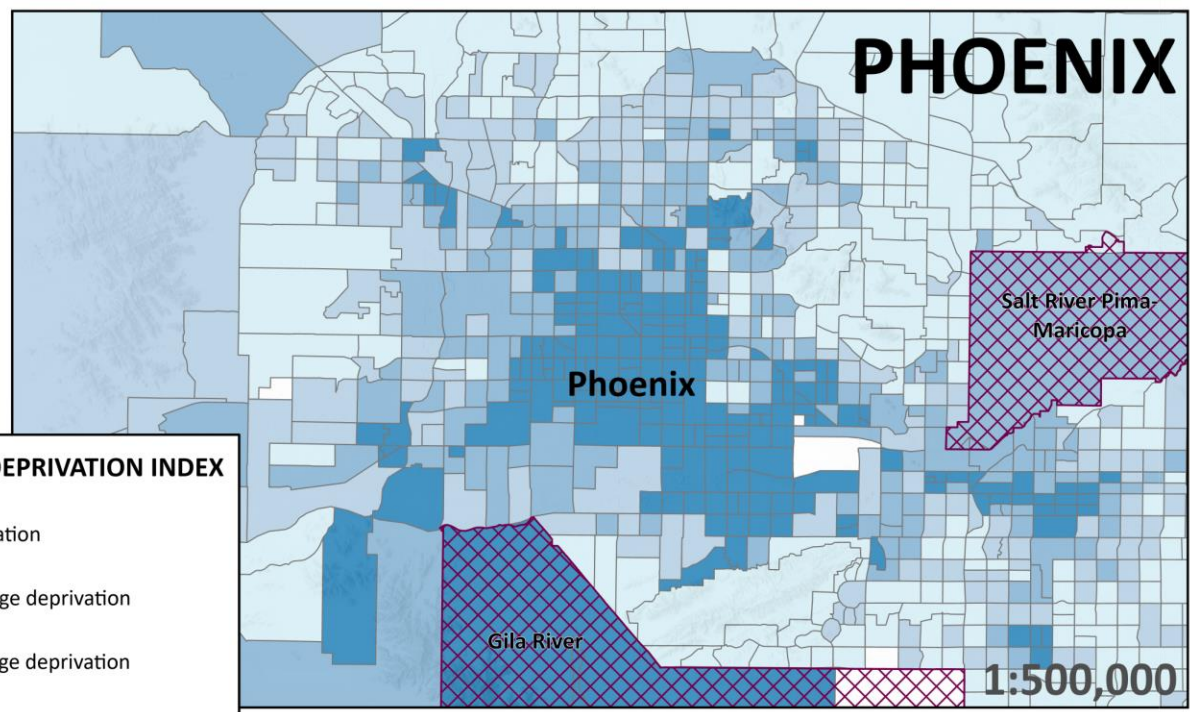
TUCSON



ARIZONA



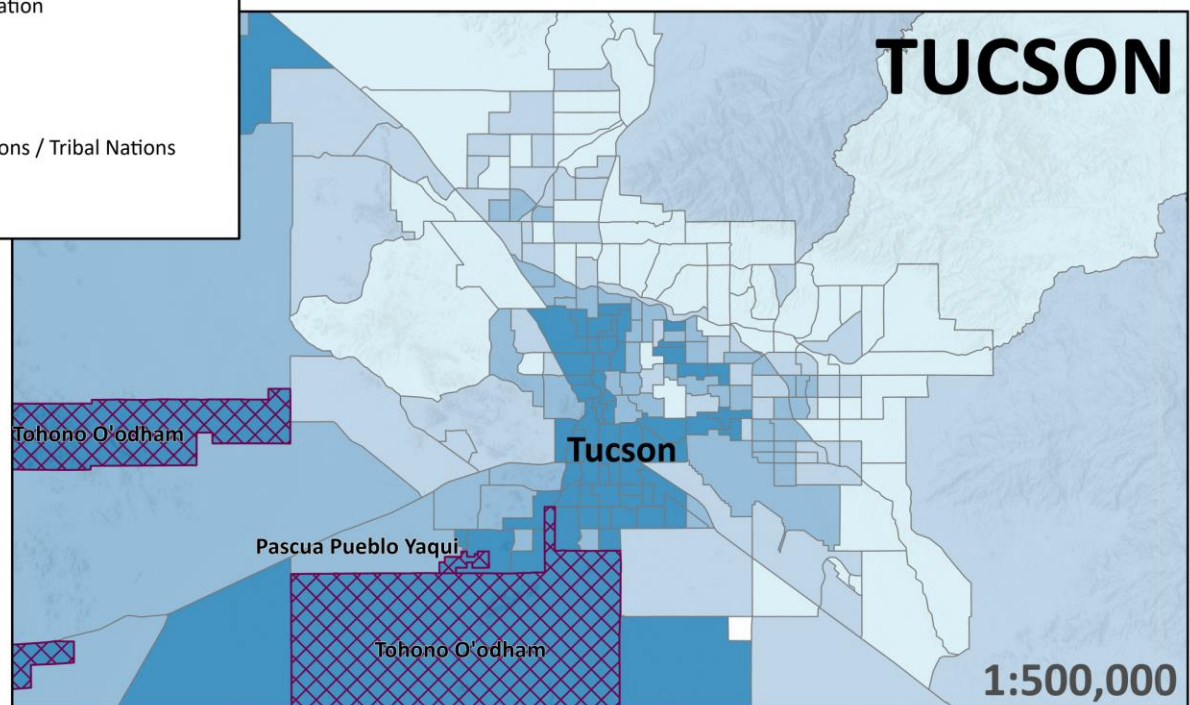
PHOENIX



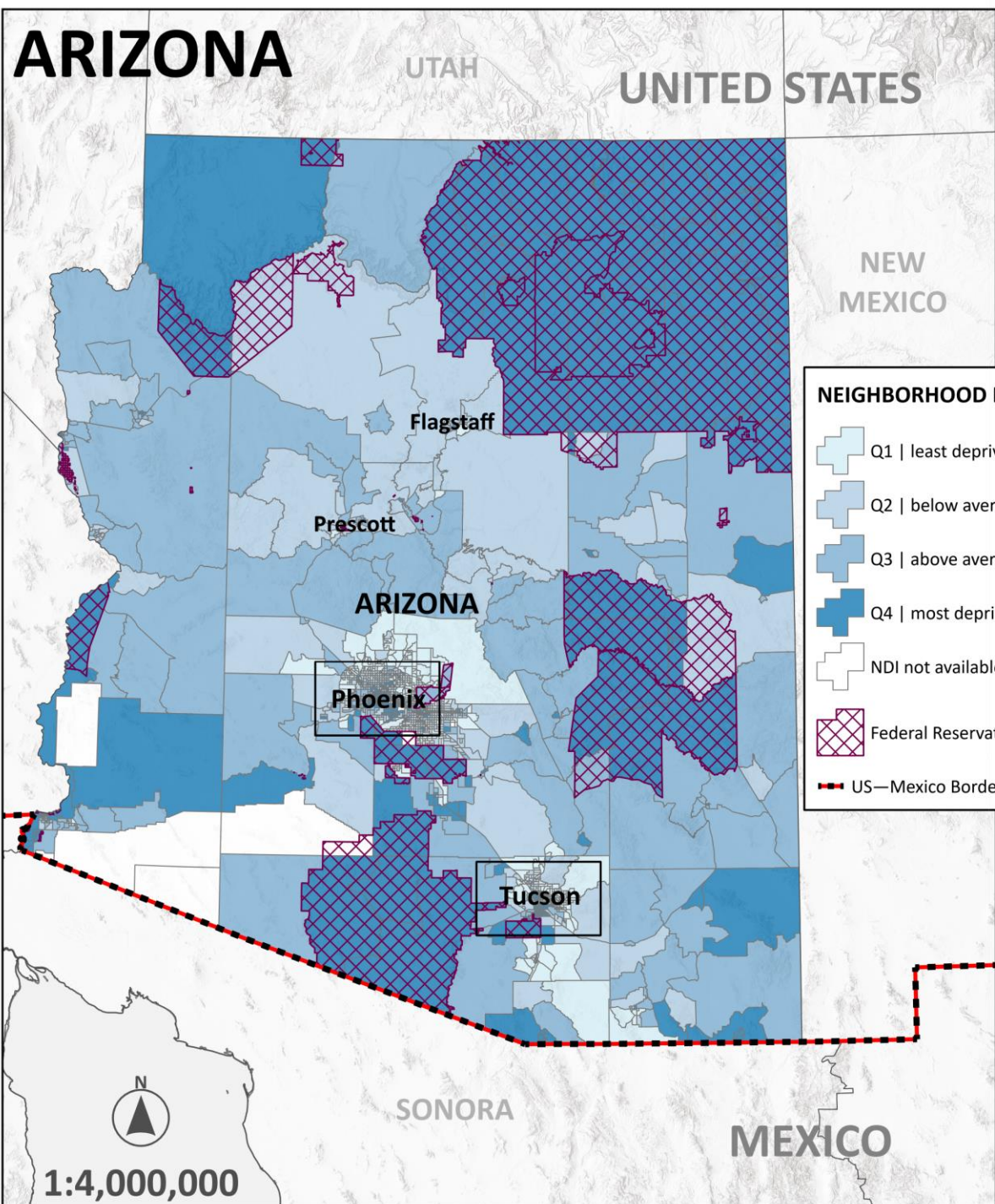
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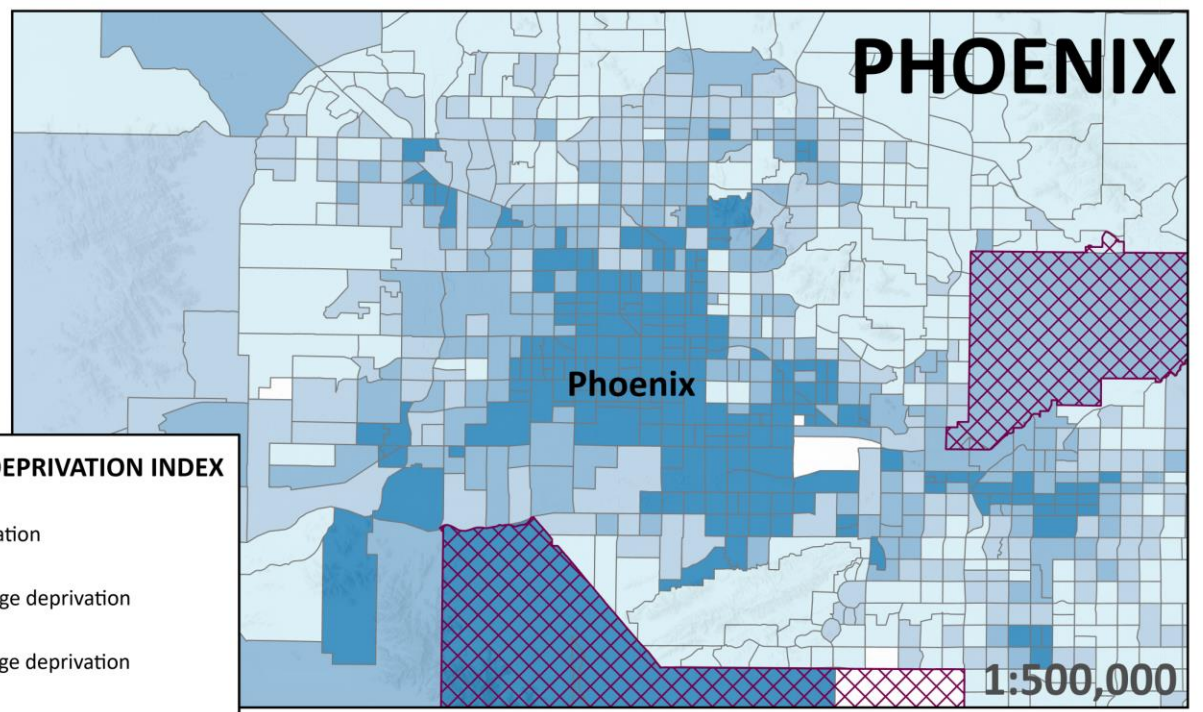
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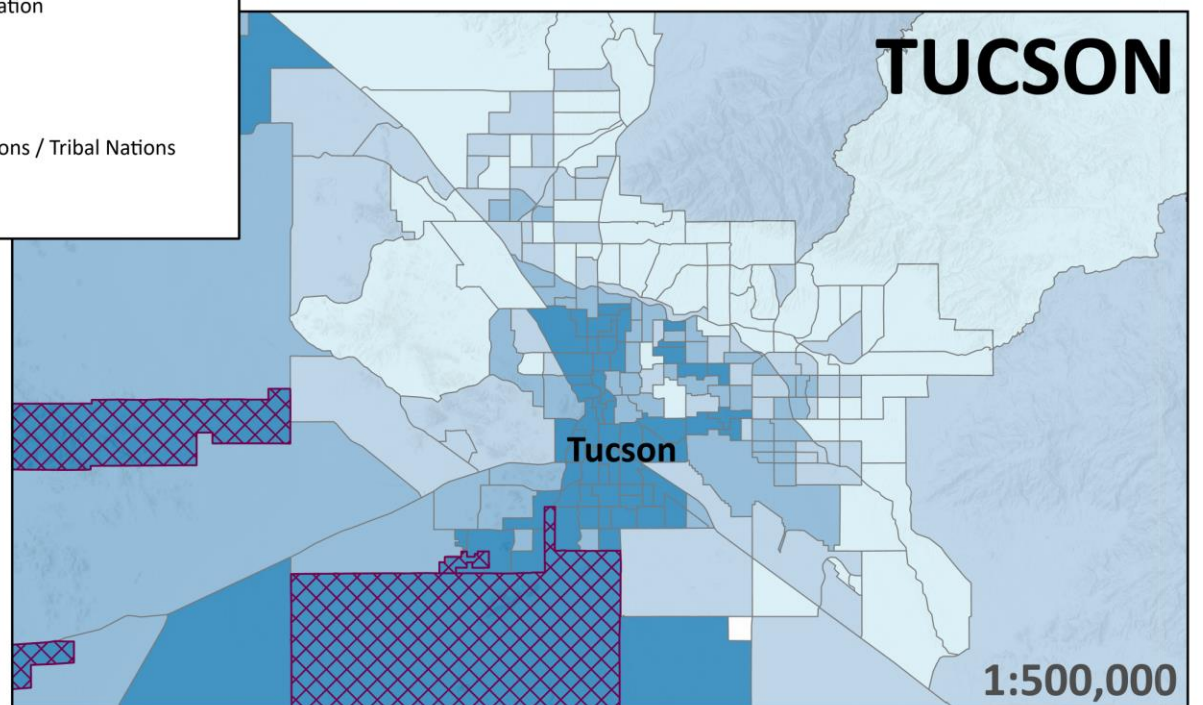
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PHOENIX



TUCSON

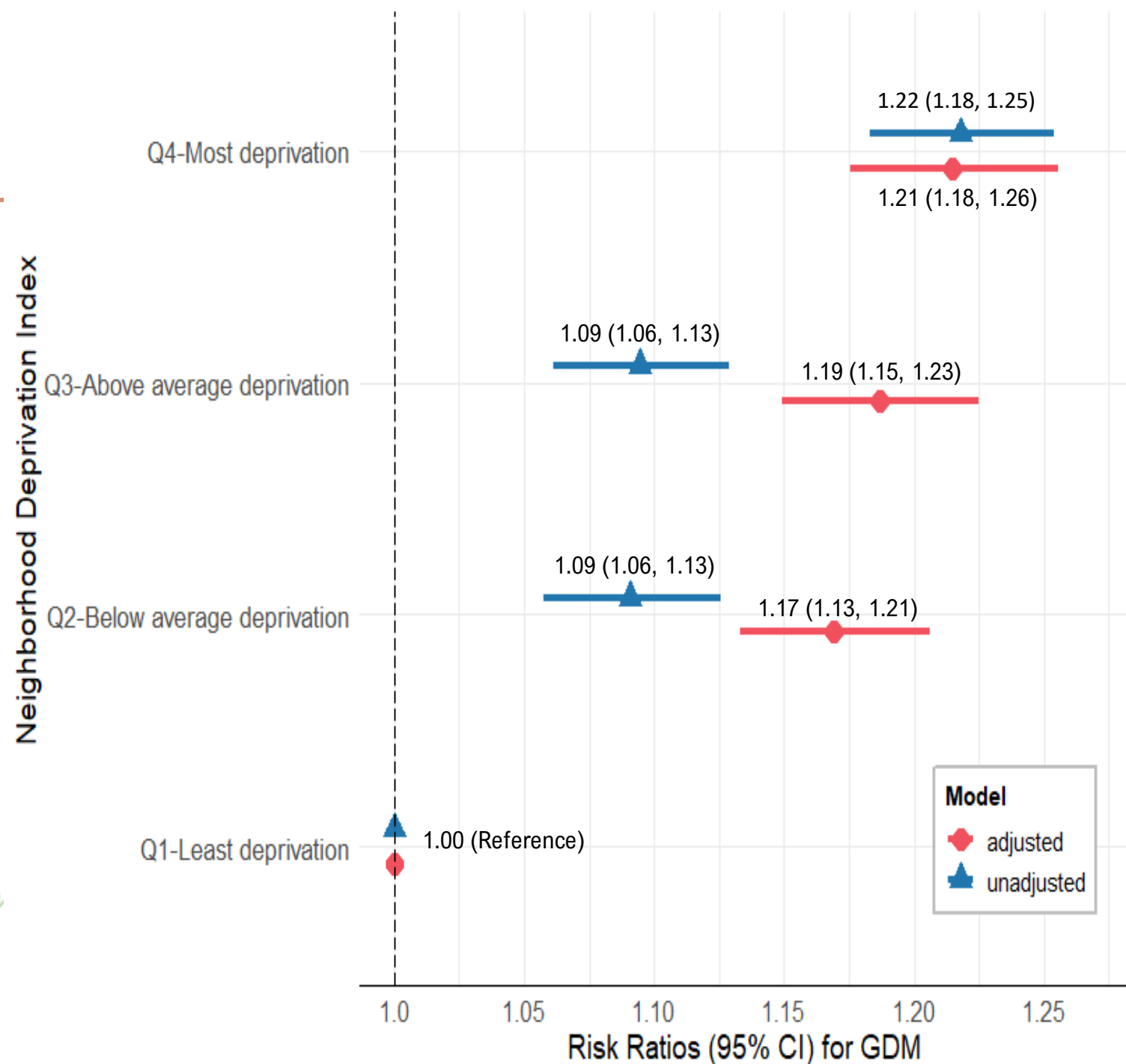


MAIN RESULTS

Adjusted for maternal age, education, race/ethnicity, parity, rurality, and birth year.

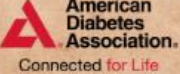


Parra et al., PPE, Under review, Unpublished, 2024



A Viable Path to Health Equity for Maternal Populations


#8 “The right to a built environment that does not put you at a greater risk for getting diabetes.”



Health Equity Bill of Rights

The health equity bill of rights envisions a future without unjust health disparities. It ensures the more than 133 million Americans living with diabetes and prediabetes, along with the millions more who are at high risk for diabetes—no matter their race, income, zip code, age, education, or gender—get equal access to the most basic of human rights: their health.

1. The right to access insulin and other drugs affordably
2. The right to healthy food
3. The right to insurance that covers diabetes management and future cures
4. The right not to face stigma or discrimination
5. The right to avoid preventable amputations
6. The right to participate in clinical trials without fear
7. The right to stop prediabetes from becoming diabetes
8. The right to a built environment that does not put you at greater risk for getting diabetes
9. The right to the latest medical advances
10. The right to have your voice heard



#HEALTHEQUITYNOW

Neighborhood Context and Diabetes Risk: Centering Health Equity

Current Evidence

Neighborhood Socioeconomic Status (NSES)

- Neighborhood deprivation (NSES) is linked to higher diabetes incidence and complication, though primarily in cross-sectional studies
- Experimental and quasi-experimental studies confirm higher type 2 diabetes incidence in low-NSES neighborhoods

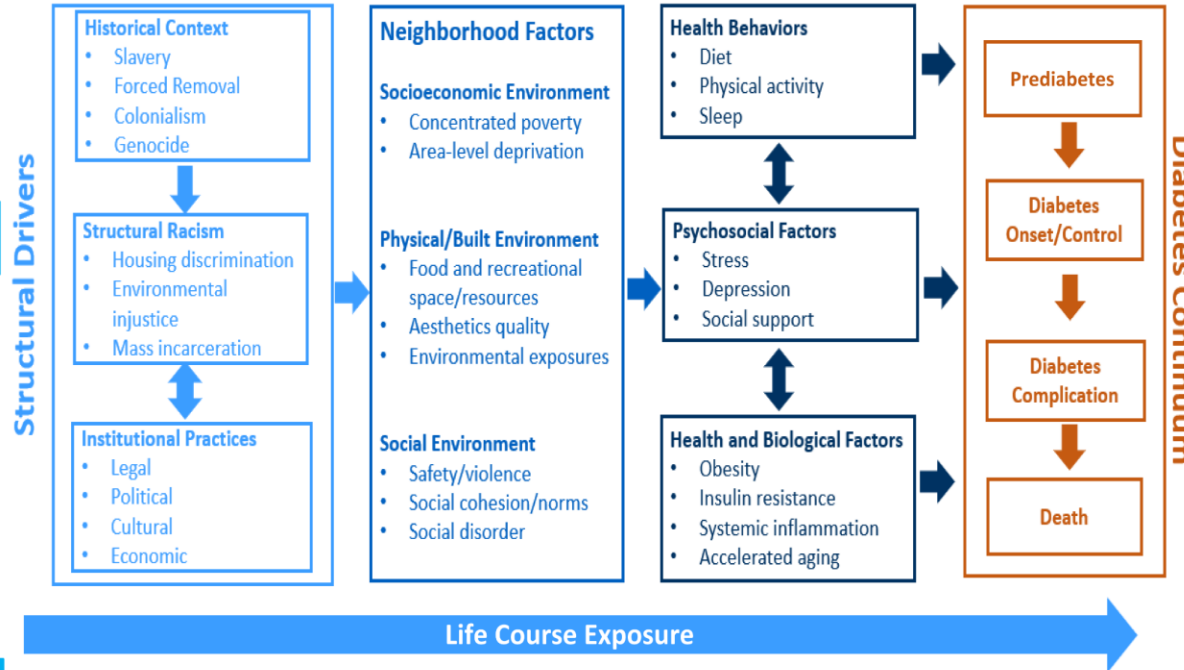
Built and Physical Environment

- Longitudinal studies consistently link poor neighborhood walkability and greenspace to higher diabetes incidence, while findings on healthy food access and availability are mixed
- Limited experimental and quasi-experimental studies were conducted on neighborhood physical environment and diabetes risk and outcomes

Neighborhood Social Environment

- Findings are mixed regarding social environment (e.g., social cohesion, crime, violence, and safety) and diabetes risk and outcomes
- Limited research exists on experimental studies assessing the impact of improving neighborhood social conditions on diabetes risk

Conceptual Framework



Future Interventions & Research

Observational Studies

- Address methodological challenges through observational studies and longitudinal design
- Incorporate life course and intergenerational investigations
- Consider social determinants of health in clinical care

Interventions

- Leverage natural experiments
- Consider neighborhood-level factors in diabetes prevention interventions
- Examine the effectiveness of place-based strategies and interventions in improving diabetes

Centering Health Equity

- Investigate historical and contemporary structural drivers, including structural racism, of place-based inequities
- Promote equitable research practices
- Provide funding and leadership for researchers from communities most impacted by health inequities

A green line-art illustration of a woman on the left holding a child on the right. To the left of the woman is a green cactus with two arms and small orange flowers. The word "LIMITATIONS" is written in bold black capital letters across the middle of the illustration.

LIMITATIONS

1

Misclassification of the Outcome:
underreporting, diagnostic criteria

2

Selection bias from live-birth,
mothers contributing to more than
>1 pregnancy

3

Misclassification of Exposure:
residential address at delivery

An illustration on the left side of the slide. It features a green line-art drawing of a doctor in a white coat examining a child. The doctor is on the left, and the child is on the right, with the doctor's hands on the child's shoulders. Below them is a green cactus with two arms and small orange flowers. The word 'STRENGTHS' is written in bold black capital letters over the doctor's figure.

STRENGTHS

1

Well-powered sample over a 7-year period.

2

NDI is a validated measure used widely in perinatal research.

3

Administrative data is cost-effective, non-invasive, and practical.

CONCLUSION

Mothers living in the area with the greatest deprivation had 21% greater risk of GDM compared to mothers living in areas with the lowest levels of deprivation (95% CI: 1.18, 1.26).

NDI as an indicator of risk for GDM has the potential to be used to select for pregnant individuals for interventions that target individual behaviors.

Strategies to mitigate neighborhood deprivation must address policy and systemic issues related to poverty and inequity -- food insecurity, poor housing quality, unwalkable neighborhoods.



Next steps for AZPEARS Study (PI: Melissa Furlong, UA)

Race and Ethnicity

Ambient Pesticide Exposure



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HARVARD
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