

Unsupervised Machine Learning Analysis of Placenta Accreta Spectrum by Geolocation and Severity

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◆ Introduction

- Evaluate associations between maternal clinical data, mid-pregnancy hematologic markers, placenta accreta spectrum (PAS) risk, and quantitative blood loss (QBL) in a high-risk obstetric population.
- Identify suspected PAS cases based on geolocation, severity, and maternal outcomes.

◆ Methods

- Retrospective cohort of 403 patients (186 PAS cases, 217 matched controls) delivering in 2018–2024.
- Twelve clinical variables (age, BMI, parity, prior cesareans) + 23 mid-pregnancy CBC markers + zip codes.
- Data reduced using Gower dissimilarity and Partitioning Around Medoids (PAM) clustering.
- Optimal clusters chosen by silhouette width + clinical interpretability in two separate analyses.
- Analyzed PAS and QBL distributions across clusters with multinomial logistic regression and ROC analysis.

◆ Results

In the first analyses of maternal clinical data and 18-22 week hematologic markers, four distinct clusters were identified:

- Clusters 1 & 2 were predominantly PAS cases
- Clusters 3 & 4 were predominantly controls
- PAS rates differed significantly by cluster ($\chi^2(3) = 201.17$, $p < 0.001$)
- 11 of 16 hematologic variables differed significantly across clusters ($p < 0.05$), including RDW1, MPV1, NEUT1, NEUT2, LYMPH2, MPV2, RDW2, PLT1, LYMPH1, PtoLR1, and PtoLR2, suggesting distinct CBC patterns by group.

The second analysis identified 6 clusters associated with geolocation and surgical diagnosis.

- Cluster 3 is associated with the “no accreta” diagnosis and correlates to the lowest EBL (1132.43 ± 642.38 ml).
- Clusters 4 & 5 were associated with the diagnosis “Percreta” and had the highest EBL
 - Cluster 4 (n=151) (2147.94 ± 1732.55 ml)
 - Cluster 5 (n=25) (2891.96 ± 2415.57 ml)
- Cluster 5 has the most distinct geolocation mean compared to the other clusters and a significantly higher EBL compared to cluster 4.
 - No difference in gestational age at delivery or unplanned delivery rate

◆ Conclusions

- Unsupervised clustering of mid-pregnancy clinical + hematologic data or geolocation + severity + EBL identified phenotypes with varying PAS and hemorrhage risks.
- May enable earlier risk stratification and tailored perioperative management in high-risk pregnancies.

Routine clinical data and hematologic markers can uncover pregnancy phenotypes, possibly enabling earlier PAS risk stratification and targeted healthcare interventions.

Additional associations between geolocation, severity, and blood loss suggest the need for further research into geographic disparities.

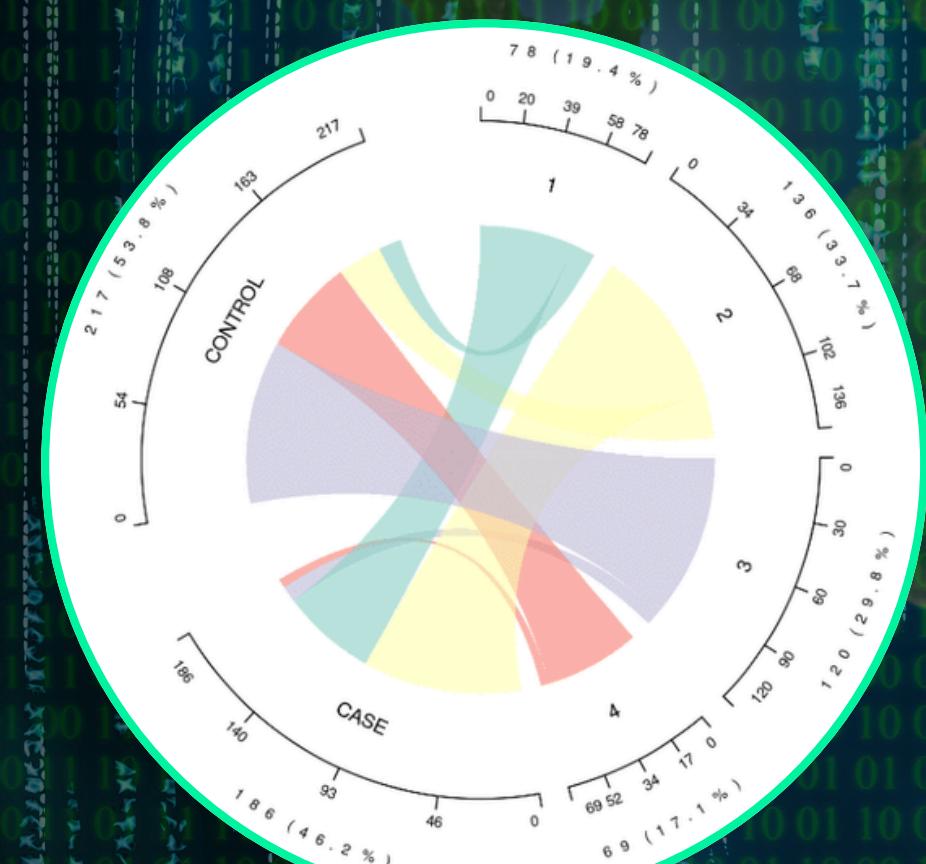
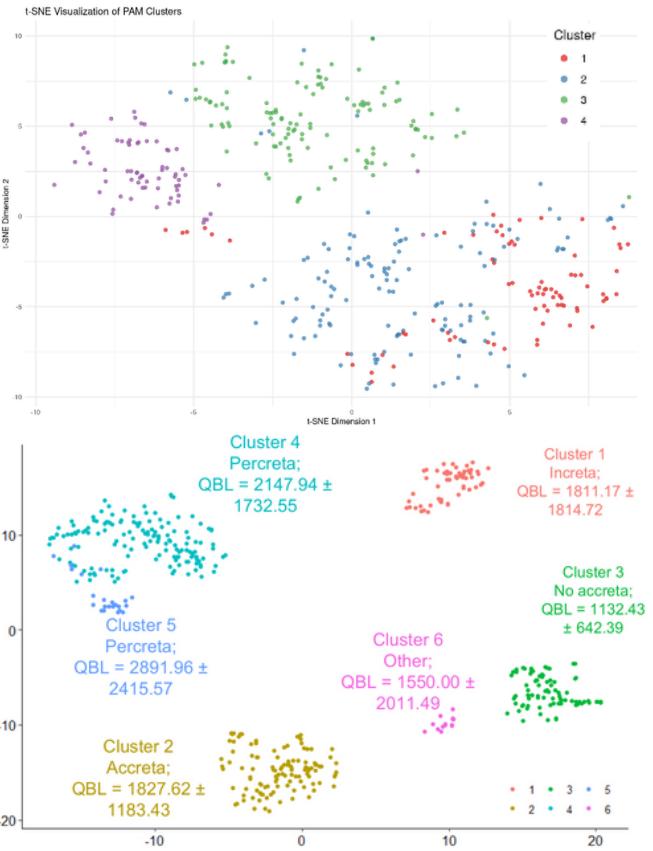


Figure 1. Circos Chord Diagram of Outcome Flow Circular
Circular chord diagram showing how PAS cases and controls distribute into each of the four clusters. Clusters 1 and 2 go with PAS cases; 3 and 4 with controls. Ribbon width corresponds to the number of patients in each cluster.

Scan here to learn more:



Figures 2a and 2b. t-SNE Plots Colored by Cluster
Two-dimensional t-distributed stochastic neighbor embedding (t-SNE) plot. Each point is a patient colored by PAM cluster, illustrating separation into four and six clusters. This visualization helps in understanding the distribution and relationships of data points within and between clusters.

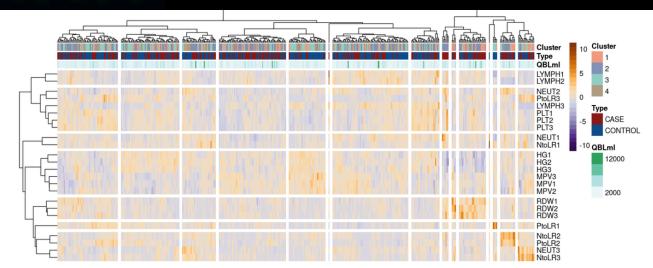


Figure 3. Heatmap of Key Blood Markers by Cluster
Heatmap of standardized median values for selected hematologic markers: lymphocytes (LYMPH), neutrophils (NEUT), platelet count (PLT), hemoglobin (HG), red cell distribution width (RDW), mean platelet volume (MPV), neutrophil-to-lymphocyte ratio (NtoLR), platelet-to-lymphocyte ratio (PLT), hemoglobin (HG), red cell distribution width (RDW), platelet-to-lymphocyte ratio (PtoLR), across timepoints 1-3. Annotations include QBL in mL (white to green), cohort (case = red, control = blue), and clusters (1-4). Rows and columns are clustered using Ward D2 with maximum distance scores.



Unseen Risks: The Hidden Link Between Social Deprivation and Maternal GBS

Christina Reed¹, Vicki Mercado², Ibeth Caceres³, Uzodinma Odu⁴, Keneshia Lane¹, Jia Chen¹, Michael Jochum¹, Haleh Sangi-Haghpeykar¹, Katie Glosson¹, Victoria Zhang¹, Yamely Mendez¹

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Background

Annually, 20 million pregnant women are colonized by Group B Streptococcus (GBS) and carry the risk of neonatal transmission. Despite prenatal screening for GBS status and prophylactic antibiotic administration, GBS remains the leading cause of neonatal morbidity, mortality, and preterm birth.^{1,2} We are yet to fully understand why GBS is relatively harmless in some women but disease-provoking in others and why some are more prone to colonization. The undeniable impact of social determinants of health (e.g., socioeconomic factors, environmental exposures) on maternal GBS colonization needs further exploration.²⁻⁵

According to the Social Deprivation Index (SDI), a composite of seven demographic characteristics collected in the American Community Survey, quantifies the socio-economic variation in health outcomes. Houston ranks relatively high for having socially deprived areas.^{6,7}

Objective: To investigate the relationship between maternal Group B Streptococcus (GBS) colonization and Social Deprivation Index (SDI) scores.

Methods

This is a retrospective, observational study. We conducted a chart review of 46,447 pregnant women using Peribank.

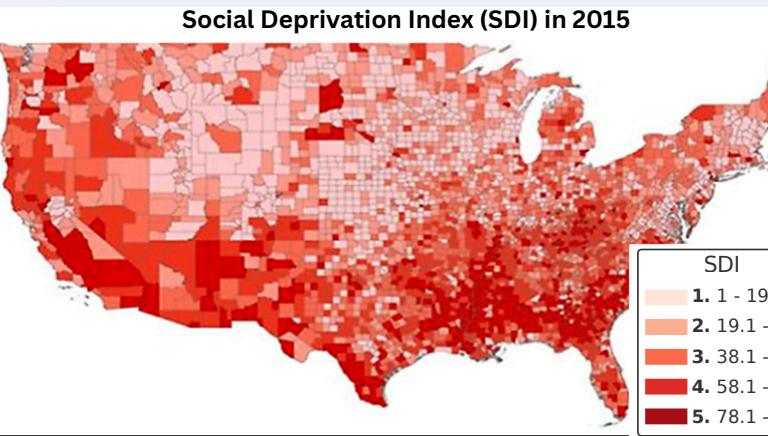
Table 1: Association between GBS and SDI Scores (Logistic Regression)

GBS	1	2	3	4	5	Total
Neg	3453 (73.27%)	2764 (73.67%)	2727 (74.37%)	4428 (73.71%)	17269 (77.01%)	30641 (75.54%)
Pos	1260 (26.73%)	988 (26.33%)	940 (25.63%)	1579 (26.29%)	5155 (22.99%)	9922 (24.46%)
Total	4713 (11.62%)	3752 (9.25%)	3667 (9.04%)	6007 (14.81%)	22424 (55.28%)	40563

P-value <0.001

Results

GBS positive cases were inversely correlated with SDI scores (p value <0.0001) using the Cochran-Armitage Trend Test.



SDI Component Description	SDI Component Formula
Percent Population Less Than 100% FPL	(Population < 0.99 FPL) / (Total Population)
Percent Population 25 Years or More With Less Than 12 Years of Education	(Population < 12 years of education) / (Total Population)
Percent Non-Employed for Population 16-64 years	(Not in Labor Force + Unemployed Between 16-64 Years) / (Civilian + Not in Labor Force between 16-64 years)
Percent Households Living in Renter-Occupied Housing Units	(Renter Occupied) / (Owner Occupied + Renter Occupied)
Percent Households Living in Crowded Housing Units	(Tenure by Occupants Per Room - (Owner Occupied + Renter Occupied)) / (Total Occupied Housing Units)
Percent Single Parent Families With Dependents < 18 years	(Single Parent Households With Dependent Children < 18 Years) / (Total Families)
Percent Households With No Vehicle	(Households Without a Vehicle) / (Total Occupied Housing U)

**Tenure by Occupants Per Room indicates that the number of occupants per room is ≥ 1.01

Additionally, women born in the US had higher odds of testing positive for GBS compared to those born outside of the US (OR=1.64, 95% CI, p value <0.0001). The odds of testing positive for GBS were higher among individuals who lived in the US for two or more years compared to those who lived in the US for less than one year (OR=1.16, 95% CI, p value =0.26). The odds of testing positive for GBS increased by 1.1% with each additional year living in the US (OR=1.011, 95% CI, p value <0.0001)..

Table 2: Odds of GBS Results by Birth Origin (Logistic Regression)

	GBS Positive	GBS Negative
Born in the U.S.	6886 (60.1%)	16478 (47.9%)
Born outside the U.S.	4566 (39.9%)	17924 (52.1%)
OR, 95% CI, P	1.64 (1.57, 1.71)	<0.0001

Table 3: Odds of GBS Results by Years in the U.S. (Logistic Regression)

Years in U.S. (Born Outside)	GBS Positive	GBS Negative
(0,1] years	261 (6.3%)	1154 (7.3%)
(0,2] years	530 (12.9%)	2234 (14.1%)
(2,∞) years	3323 (80.8%)	12450 (78.6%)
OR (95% CI), p (years in U.S. continuous): 1.011 (1.007, 1.015), <0.0001		

The mean SDI score for the group not tested for GBS (n=5882) was 71.56 (SD=29.25), while the mean SDI score for the group tested for GBS (n=40565) was 69.60 (SD=30.15). A T-test analysis showed a statistically significant difference in mean SDI scores between the two groups (p value<0.0001), with the group not tested having a higher mean SDI score by 1.96. The primary reason for women not tested for GBS was preterm delivery (p<0.0001) rather than SDI scores.

Table 4: GBS Not Tested vs. Tested with SDI Categories 1-5 (T-Test)

GBS	Mean SDI	95% CI
Not Tested	71.56	70.81 - 72.30
Tested	69.6	69.30 - 69.89

T-Test Results
Mean SD Difference: 1.96
P-value <0.0001

Table 5: GBS Not Tested vs. Tested with Gestational Week at Delivery (x2 Test of Independence)

GBS Test	Sample Size (N)	Mean Gestational Age at Delivery	Standard Deviation	Percentage of Total
Not tested	5917	36.71	3.4	12.41%
Tested	41704	38.44	1.91	87.59%

P-value <0.0001

Conclusion

Lower SDI scores, indicating less social deprivation, correlates with higher GBS testing and colonization. US- born women and longer residence in the US are correlated to higher GBS positivity.

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Background

Each year, 20 million pregnant women are colonized with Group B Streptococcus (GBS), increasing the risk of neonatal transmission. Despite universal screening and prophylactic antibiotics, GBS remains a leading cause of neonatal morbidity, mortality, and preterm birth.^{1,2} The reasons why GBS is asymptomatic in some women but disease-provoking in others, and why colonization risk varies, remain poorly understood. The role of social determinants of health, including socioeconomic status and environmental exposures, on maternal GBS colonization requires further study.²⁻⁵

The Social Deprivation Index (SDI), a composite of seven demographic factors from the American Community Survey, quantifies socioeconomic variation in health outcomes. Houston ranks among the most socially deprived areas in the US.^{6,7}

Objective: To investigate the relationship between maternal Group B Streptococcus (GBS) colonization and Social Deprivation Index (SDI) scores.

Methods

We conducted a retrospective observational study using the Peribank database, which prospectively obtained consent and collected data on >70,000 deliveries from 2012–2023. A chart review of 46,447 pregnant women was performed collecting maternal GBS testing results, birth place, zip code, and pregnancy outcomes.

References



Results

GBS positive cases were inversely correlated with SDI scores (p value <0.0001) using the Cochran-Armitage Trend Test. (Table 1)

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P-value <0.001						

Women born in the US had higher odds of testing positive for GBS compared to those born outside the US (OR=1.64, 95% CI, p <0.0001, Table 2). Among foreign-born individuals, those living in the US for ≥ 2 years had higher odds of GBS positivity than those living <1 year (OR=1.16, 95% CI, p =0.26, Table 3). Additionally, for women born outside the US, the odds of GBS positivity increased by 1.1% for each additional year of residence (OR=1.011, 95% CI, p <0.0001, Table 3).

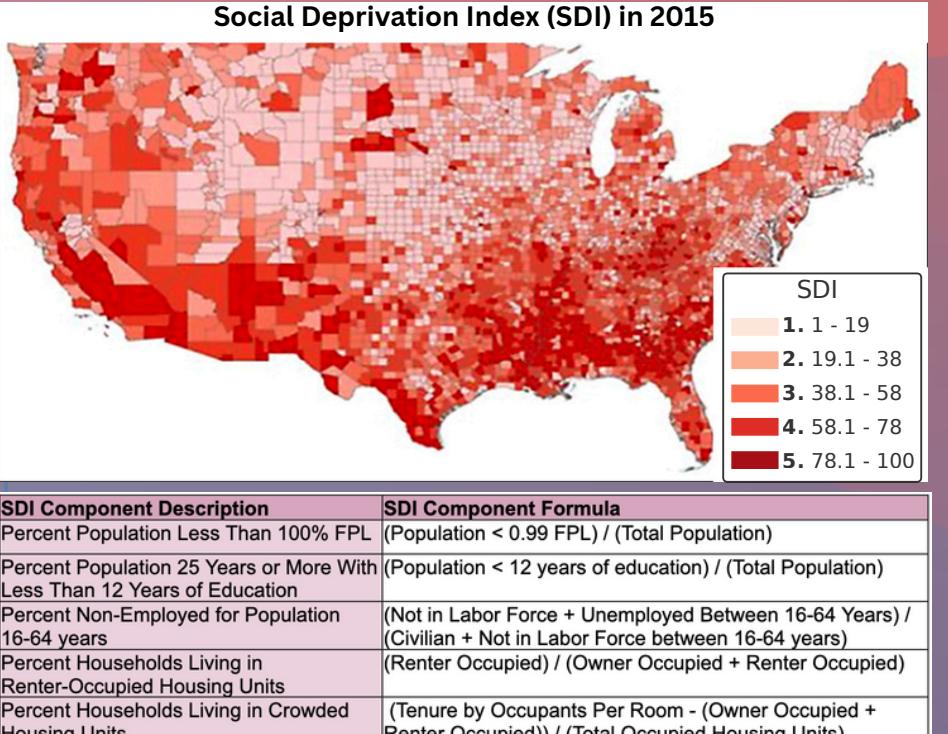
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The mean SDI score was higher among women not tested for GBS (71.56, SD=29.25; n=5,882) compared to those tested (69.60, SD=30.15; n=40,565). A t-test analysis showed that the difference of 1.96 was statistically significant (p <0.0001, Table 4). However, the primary reason for not being tested was preterm delivery (p <0.0001, Table 5), not SDI score.

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Conclusion

Lower SDI scores, reflecting less social deprivation, were associated with higher rates of GBS testing and colonization. US-born women and those with longer residence in the US demonstrated higher odds of GBS positivity. These findings suggest that both social determinants of health and acculturation may influence maternal GBS risk, underscoring the need for further investigation into sociobiological mechanisms driving colonization.

ACKNOWLEDGEMENTS AND CONTACT INFORMATION

We thank Dr. Kjersti Aagaard, Dr. Haleh Sangi, and the Peribank Team (IRB H-26364, PI: Jia Chen) for their essential support.

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