County-level Analysis of Perinatal Health Indicators Within a Single Health System Catchment

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Abstract

Background: Adverse perinatal health outcomes are disproportionately impacted in rural communities. Social determinants of health (SDoH) defined by nonclinical social, behavioral, and economic factors may impact up to 90% of health outcomes in rural communities.

Objective: To evaluate county-level perinatal patterns in health outcomes, health behaviors, socioeconomic vulnerability, and healthcare providers across rural and non-rural Florida counties within a single health system catchment.

Methods: Socioeconomic vulnerability metrics, digital connectivity, licensed provider metrics, and behavioral data and were obtained from Floridahealthcharts.com and the County Health Rankings. County-level birth and perinatal health outcome data were obtained from the Florida Department of Health. The University of Florida Health Perinatal Catchment Area (UFHPCA) was defined as all Florida counties where $\geq 5\%$ of all infants were delivered at Shands Hospital in Alachua county between June 2011 and April 2017. County-level rurality was determined by Florida Statutes 288.0656 rurality designations.

Results: The UFHPCA included three non-rural and ten rural counties that represented more than 64,000 deliveries over a 5-year 9-month period. We found that nearly 1 in 3 infants resided in a rural county ($n=20,899$), and 7 out of 13 counties did not have a licensed obstetrician gynecologist. Nine counties reported maternal death rates that were between 1 and 4-fold higher than the statewide rate, and rural counties generally reported neonatal mortality and preterm birth rates that were higher than the statewide averages. We found maternal smoking rates (range 6.8% – 24.8%) were above the statewide rate (6.2%) for all counties in the catchment. Except for Alachua county, breastfeeding initiation rates (range 54.9% - 81.4%) and access to household computing devices (range 72.8% - 86.4%) were below the statewide rate (82.9% and 87.9%, respectively). Finally, we found that childhood poverty rates (range 16.3% - 36.9%) in our catchment was above the statewide rate (18.5%), except for Suwanee and Columbia counties.

Conclusions: The health burden of the UFHPCA is characterized by both rural and non-rural counties with increased maternal and neonatal death and preterm birth, as well as adverse health behaviors that include smoking during pregnancy and lower levels of breastfeeding.

Introduction

Adverse perinatal health outcomes including maternal and infant mortality are far higher in the United States than in similarly large and wealthy countries (1,2). In 2017, the World Health Organization reported that the US was one of only two countries to report a significant increase in maternal mortality since 2000 (3). Despite significant advances in clinical care (7–9), there is a growing awareness that up to 90% of health outcomes are the result of nonclinical factors –known as the social determinants of health (SDoH)- which include social, behavioral and economic domains (10). Perinatal health disparities are more likely among women who are young, low-income, African American, unmarried, less educated, receiving federal assistance (i.e., The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)), are overweight or obese before pregnancy, or reported their pregnancy was unintended (4). Maternal healthcare spans pregnancy through the postpartum period (5) and prenatal care is essential for a healthy pregnancy and delivery (6). Among mothers who did not receive prenatal care, low birth weight of their infant is three to five times more likely to occur, and infant death following delivery is five times more likely to occur compared to those mothers who receive adequate prenatal care (2).

Common social determinants that are used to explain disparities in health outcomes are income, unemployment, education, racial or ethnicity, or geography (11). In many areas of the US, the racial discrimination experienced by minority populations is negatively associated with health outcomes, and the prevalence of adverse health outcomes throughout childhood often persists despite increasing income and education levels (12,13). The impact of SDoH on health outcomes

is likely mediated through a complex interaction among health behaviors, clinical care, social and economic factors, and an individual's physical environment (10). As an example, maternal education and household income (14) are important modifiers of perinatal health behaviors such as maternal smoking (15,16) and breastfeeding success (17). Maternal education across all racial groups remains the strongest factor that influences breastfeeding initiation and duration (18) and smoking cessation success (16). Nearly twice as many higher-income women breastfeed exclusively at six months as compared to their lower-income counterparts (19). With respect to maternal smoking, low socioeconomic status was associated with higher risk of smoking at the time of conception and continued smoking during pregnancy (15). Taken together, SDoH at the individual-level include factors such as education and income that occur outside of the health care provider's office and impact perinatal health outcomes.

We defined and examined a perinatal health catchment area for University of Florida (UF) Health Shands Hospital, a single health care system with broad regional reach in north central Florida, in order to identify opportunities to improve health related to social determinants. Defining a geographical area around a healthcare service point is important to not only estimate community needs but also facilitate planning of healthcare initiatives (20). We characterized county-level patterns in perinatal health outcomes and behaviors, socioeconomic vulnerability, and the availability of healthcare providers across rural and non-rural Florida counties within this single health system catchment. The long-term goal of the UFHPCA is to facilitate collaborations in which researchers, providers, public health practitioners, and nonprofit organizations can utilize the data to develop or expand applied perinatal research, planning, and implementation, with an emphasis on improving local health outcomes.

Data And Methods

Perinatal Catchment Definition: The UFHPCA was defined at the county level from births occurring at UF Health Shands Hospital. We obtained electronic health records (EHR) from UF Health Shands Hospital that included all live births occurring between June 2011 and April 2017 (21). Linkage of maternal-infant records to obtain mother's residential 5 or 9 digit zip code was completed by an honest broker within the University of Florida Health Integrated Data Repository (IDR) before releasing the de-identified data to the research team. ZIP codes from the delivery encounters were available on 99.1% of records. Nine-digit and most 5-digit zip codes were linked to county. The number of births from 5-digit zip codes that cross county borders were aggregated to the county level using the 2010 ZIP Code Tabulation Area (ZCTA) to County Relationship File from the U.S. Census Bureau (22). UF Health EHR birth counts per county were compared to county birth counts from the Florida Bureau of Vital Statistics during the same period (June 2011 to April 2017). We defined the UFHPCA as all counties where 5% or more of county births occurred at UF Health. **Supplementary Figure 1** outlines selection of EHR records included in this study. The EHR record data was used purely to define the UFHPCA boundary.

State and Local Data: Socioeconomic vulnerability metrics, digital connectivity, licensed provider metrics, and behavioral data and were obtained from Floridahealthcharts.com and the County Health Rankings (CHR). County level birth and perinatal health outcome data were obtained from the Florida Department of Health.(23) To match the time of the EHR records, rates for each measure were calculated from FL Health Charts' annual rates between 2011-2017 and weighted by county-level annual population. Counts for each year's numerator and denominator were obtained and aggregated to generate one rate for June 2011 to April 2017. All data visualization and tables were created using R statistical software (24). FL Health Charts provided rates of computing device access beginning in 2017. The 2021 CHR z-scores were obtained for all 67 Florida counties as an established framework to rank each county within Florida from most to least healthy (25).

Primary Outcomes: Perinatal health outcomes included maternal mortality, neonatal mortality, and preterm birth. Behavioral outcomes included breastfeeding initiation rates and non-smoking rates during pregnancy. Socioeconomic vulnerability metrics included rates of families with related children younger than 5 years above the poverty line and rates

of households with one or more computing devices. Healthcare access included number of licensed pediatricians, obstetrician gynecologists (OB-GYNs), and family practice physicians.

Rurality Designations: Rurality on the county level was identified according to rurality designations defined by Florida Statutes 288.0656. A county was designated as rural if the population did not exceed 75,000, or if the population did not exceed 125,000 and was contiguous to a county with a population of less than 75,000 (26).

Analysis: Once counties meeting the threshold to be designated within the UFHPCA were identified, county-level rates of perinatal behaviors, socioeconomic vulnerability metrics, and licensed provider metrics were compared to state-wide rates. The ggplot2 and grid packages were used to visualize rates geographically by county (27,28). County rates were ranked by rates for interpretation.

Results

UF Health Shands Hospital delivered 16,711 infants between June 2011 and April 2017. Of those infants, 112 were unable to be linked to a mother and excluded from the study. Zip code data was missing for a further 43 infants, and the remaining 16,566 infants were linked to a county of residence (**Supplementary Figure 1**). Out of 67 counties in the state of Florida, we identified the perinatal catchment area as 13 counties where $\geq 5\%$ of infants within the county were delivered within the UF Health system (**Table 1**). Counties included in the UFHPCA were Alachua, Citrus, Marion, Putnam, Bradford, Columbia, Union, Suwannee, Gilchrist, Levy, Hamilton, Dixie, and Lafayette. The UFHPCA included three non-rural counties and ten rural counties.

Table 1. County-Level Demographics of UF Health Perinatal Catchment Area

Geographic Features				Population Demographics (% of Population in 2017)					Birth Data (June 2011 - April 2017)	
County	Rurality	Density	Population	NH White	NH Black	NH Other	Hispanic	Females 18-35	Live Births	Shands Births (%)
Alachua	Non-Rural	297.0	259349	62.0	20.0	8.6	9.4	19.4	17034	42.3
Citrus	Non-Rural	243.0	144922	88.5	2.8	3.3	5.4	6.9	6161	5.5
Marion	Non-Rural	217.0	352067	71.4	12.5	3.6	12.5	9.3	20200	18.5
Putnam	Rural	99.6	73068	71.8	15.9	2.6	9.8	9.5	4933	10.0
Bradford	Rural	91.1	27808	74.3	19.0	2.8	3.9	9.2	1789	26.5
Columbia	Rural	85.9	69250	72.9	17.8	3.3	6.0	10.0	4777	13.4
Union	Rural	62.8	15896	69.4	22.4	2.5	5.7	7.4	961	23.1
Suwannee	Rural	63.6	44527	75.7	12.9	2.3	9.1	9.0	2718	16.6
Gilchrist	Rural	49.2	16977	87.4	4.6	2.4	5.6	9.2	1131	36.5
Levy	Rural	35.5	40832	80.1	9.0	2.7	8.3	9.4	2324	45.9
Hamilton	Rural	27.7	14749	55.0	33.2	2.8	9.1	7.9	911	16.8
Dixie	Rural	23.2	17040	84.0	9.6	2.3	4.2	7.7	925	42.5
Lafayette	Rural	16.0	8651	71.1	14.5	2.1	12.4	8.0	430	29.9

Note: Population Density retrieved from U.S. Census Bureau 2010 10-year Estimate. Population Density measured in square miles. Population and demographic data provided by FLHealthCharts.com, which is managed by the Florida Department of Health, Division of Public Health Statistics & Performance Management.

NH = Non-Hispanic.

Analysis from the County Health Rankings revealed that twelve out of thirteen counties in the UFHPCA had a positive health outcomes z-score, indicating a high health burden compared to the state rate (**Figure 1**). According to the Florida Department of Health, the total population of the UFHPCA in 2017 was 1,085,136. During the study period, there were 64,294 live births with 32.5% (20,899) of deliveries coming from rural counties. The percentage of live births at UF Health Shands Hospital across the UFHPCA ranged from 5.5% in Citrus County to 45.9% in Levy County (**Table 1**). Alachua, Bradford, Gilchrest, Levy, Dixie, and Lafayette all had approximately 30% or more of live births at Shands Hospital.

We found that four counties in our analysis reported no maternal deaths during the period studies; however, the remaining nine counties reported age-adjusted maternal death rates that were 1 to 4-fold higher than the statewide rate of 2.1% deaths per 100,000 population (**Table 2**). With respect to infant mortality, we found that twelve of the thirteen counties in the UFHPCA reported mortality rates (6.4 - 13.1 deaths per 1,000 live births) that were above the state-wide rate (6.1 deaths per 1,000 live births). We also found that preterm birth rates (**Figure 2**, 9.0 - 13.1 preterm infants per 1,000 live births) among the UFHPCA counties were above the state-wide rate of 10.1 infants per 1,000 live births except for Marion, Citrus, and Gilchrist counties which had rates of 9.0, 10.1, and 9.0 respectively. All counties in the UFHPCA had maternal smoking rates (**Figure 3**, 6.8% - 24.8%) above the statewide rate (6.2%). Within the UFHPCA, only Alachua County (84.3%) had a

higher breastfeeding initiation rate than the statewide rate (82.9%), with the remaining catchment counties' rates ranging from 52.8% to 81.4% (**Figure 4**).

Table 2. UF Health Perinatal Catchment Area Health Outcomes and Health Behaviors

Area	Perinatal Health Outcomes			Perinatal Behaviors	
	Maternal Deaths (Age-adjusted rate per 100,000 population)	Infant Mortality (Per 1,000 live births)	Preterm Births (Per 1,000 live births)	Births to Smoking Mothers During Pregnancy (%)	Births to Mothers Who Initiate Breastfeeding (%)
Florida	2.1	6.1	10.1	6.2	82.9
Alachua	3.0	8.0	10.4	6.8	84.6
Citrus	2.4	7.1	10.1	23.0	74.2
Marion	2.2	8.1	9.0	13.5	74.9
Putnam	5.5	8.0	11.8	20.2	75.3
Bradford	4.8	11.9	11.6	21.9	71.4
Columbia	2.1	9.1	11.0	17.6	68.4
Union	0.0	4.1	13.1	20.9	70.1
Suwannee	0.0	7.9	11.3	16.3	70.4
Gilchrist	0.0	7.0	9.0	15.5	81.4
Levy	3.3	7.3	11.1	18.2	78.6
Hamilton	8.8	10.6	10.5	15.2	54.9
Dixie	9.1	6.4	11.9	24.8	70.1
Lafayette	0.0	6.0	11.9	16.3	73.2

Note: Data provided by FLHealthCharts.com, which is managed by the Florida Department of Health, Division of Public Health Statistics & Performance Management. Data captures only actively licensed providers for each fiscal year July 1 - June 30 during the 2011 to 2017 period.

All counties other than Columbia (17.6%) and Suwannee (16.3%) in the catchment had childhood poverty rates that exceeded the statewide rate of 18.5% of families with young children living in poverty (**Table 3, Figure 5**, 20.7% - 36.9%). All counties other than Alachua county (89.0%) in the UFHPCA had lower rates of access to computing devices in 2017 than the statewide rate (87.9%), (**Figure 6**, 60.5% - 86.4%). Three rural counties with the lowest access to computing devices in 2017 were Union (72.7%), Bradford (72.8%), and Dixie (69.5%) counties. Seven rural counties in the UFHPCA did not have a licensed OB-GYN in the entire county. Twelve out of thirteen counties in the UFHPCA were below the statewide rate for at

least one type of provider during the period studied. For the thirteen counties in the UFHPCA, ten had fewer than 50% of the state average density for licensed pediatricians, seven had fewer than 50% of the state average density for family practice physicians, and nine had fewer than 50% of the state average density for OB-GYNs.

Table 3. UF Health Perinatal Catchment Area Socioeconomic Vulnerability and Healthcare Access

Area	Socioeconomic Vulnerability (%)		Licensed Providers Available (Per 100,000 population)		
	Families with Related Children (<5 years) Below the Poverty Line	Households with One or More Computing Devices	Pediatricians	Family Practice Physicians	OB-GYNs
Florida	17.5	87.9	19.6	21.4	9.7
Alachua	20.7	89.0	64.6	45.8	21.4
Citrus	26.7	86.4	7.0	21.5	4.0
Marion	26.1	83.5	8.2	18.1	4.8
Putnam	30.3	75.9	8.5	11.2	9.1
Bradford	21.9	72.8	1.8	15.2	0.6
Columbia	17.6	85.5	5.9	15.7	2.0
Union	20.9	72.7	1.1	8.5	0.0
Suwannee	16.3	82.4	0.4	3.8	0.0
Gilchrist	33.3	78.2	6.9	5.9	0.0
Levy	36.9	79.7	1.7	13.2	0.0
Hamilton	33.7	76.7	0.0	2.3	0.0
Dixie	24.8	69.5	4.1	7.1	0.0
Lafayette	34.7	77.7	0.0	1.9	0.0

Note: Data provided by FLHealthCharts.com, which is managed by the Florida Department of Health, Division of Public Health Statistics & Performance Management. Data captures only actively licensed providers for each fiscal year July 1 - June 30 during the 2011 to 2017 period.

Discussion

Summary: Geographic variation in health outcomes has consistently demonstrated that rural communities are disproportionately affected (29–32) in the domains of mortality and clinical care (33). This study identified thirteen Florida counties as part of the UFHPCA which included rural and non-rural counties, representing more than 64,000 deliveries over nearly five years. Twelve out of thirteen counties in the UFHPCA had a higher health burden compared to the state rate, while three catchment counties were in the top five Florida counties for overall health burden. Our analysis

revealed that nearly 1 in 3 infants (32.5%) within the UFHPCA reside in a rural county. We also found counties that reported a 4-fold increase in maternal death rates relative to the statewide average. Rural counties in our analysis reported neonatal mortality and preterm birth rates that were generally higher than the statewide averages. Rural counties within the catchment were characterized by higher levels of smoking during pregnancy, increased childhood poverty rates, lower levels of breastfeeding initiation, and more limited access to computing devices when compared to the state of Florida as a whole. Analysis of perinatal health care providers revealed that rural counties had fewer licensed providers in the areas of family medicine, obstetrics, and pediatricians. Collectively, our results revealed that relative to statewide averages, North Central Florida is characterized by both rural and non-rural counties with higher maternal and infant mortality as well as higher levels of smoking during pregnancy and childhood poverty and lower levels of breastfeeding.

Health Care Access: A perinatal healthcare desert is defined as geographic areas that lack adequate obstetric health services (34). In 2014, less than half of all rural counties in the US had hospital-based obstetric care (35), emphasizing the impact of socioeconomic status and transport resources (36) on adequate health care services for rural populations. An important observation made by this study is that seven out of thirteen counties in our analysis did not have a licensed obstetrician gynecologist, suggesting that patients living in these areas may reside within a perinatal healthcare desert. Women living in perinatal healthcare deserts experience much higher rates of adverse outcomes during pregnancy and childbirth compared to those living outside these areas (37). In Louisiana from 2016-2017, women living in perinatal healthcare deserts experienced a 91% increase in risk of maternal mortality during pregnancy and up to one year postpartum, regardless of the women's age, race or ethnicity, or socioeconomic status. Our results were generally consistent with these observations, whereby maternal mortality was the highest in counties without a licensed obstetrician gynecologist. Given the complexity of healthcare accessibility in rural communities (38,39), our results highlight the importance of defining "high-risk" areas that can inform precision public health interventions focused on reducing maternal mortality in rural communities (40).

Maternal Mortality: The US consistently ranks last in maternal mortality among industrialized nations, with approximately 700 women each year dying due to pregnancy or delivery complications (2). Kozhimannil *et al* found that rural residents had a 9 percent greater probability of severe maternal morbidity and mortality during pregnancy, compared with urban residents (41). Moreover, estimates suggest that nearly 3 in 5 pregnancy-related deaths in the US are potentially preventable and this proportion can vary, with some cases indicating that up to 90% of maternal deaths may be preventable (42–44). We found that four counties in our analysis reported no maternal deaths during the period studied; however, the remaining nine counties reported age-adjusted maternal death rates that were 1 to 4-fold higher than the statewide rate of 2.1% deaths per 100,000 population. Previous work in Florida has demonstrated that overall public health expenditures were not directly associated with improvements perinatal health outcomes such as maternal deaths (45). Specifically, Bernet *et al.* reported that pregnancy-related public health programs across all 67 Florida counties resulted in statistically significant reductions in high-risk groups that included the black maternal death rate and the black-white maternal death gap after adjusting for income, employment and access to care (45). Although these analyses did not consider rurality, clinical efforts to reduce maternal deaths in rural communities includes the development of evidence-based clinical practices called maternal safety bundles that are designed to reduce the incidence of and risks associated with severe maternal morbidity and mortality (41). Taken together, public health policies and clinical practices that aim to address maternal mortality should ensure the representation of rural residents within decision-making bodies and public health interventions (46).

Health Behaviors: Maternal health behaviors during pregnancy and delivery are key determinants of infant outcomes. Our study revealed that all counties in the UFHPCA had maternal smoking rates that were higher than the statewide average. Prenatal smoking increases risks of adverse pregnancy outcomes, including stillbirth (47), preterm birth (48), and infant mortality (49). We also found that 12 counties in the UFHPCA had lower breastfeeding initiation rates than the statewide average, with the exception of Alachua county. As advised in the Center for Disease Control's Breastfeeding Report Card,

2020, individualized support in the first few hours and days is critical to help mothers meet their breastfeeding goals. Our analysis also revealed that rural counties generally reported neonatal mortality and preterm birth rates that were higher than the statewide averages. Family poverty, another SDoH, influences many aspects of perinatal health, including maternal diet and exercise and access to perinatal care. Poverty is one component of socioeconomic status, which has also been intimately associated with birth weight (50). Birth weight is tied to many outcomes during the perinatal period and long-term health (51). Higher poverty is associated with a lower birth weight (52). Our study revealed that every county in the UFHPCA exceeded the Florida statewide rate of poverty. Taken together, our results demonstrate that UFHPCA counties had some of the lowest breastfeeding initiation rates across the state of Florida which highlights the need for innovative public health interventions that promote breastfeeding in rural and non-rural areas. For example, a meta-analysis identified smoking as an important factor for breastfeeding, where nonsmoking mothers had higher breastfeeding initiation and continuation rates (53). Recognizing that many of the counties in the UFHPCA had both higher maternal smoking rates and lower breastfeeding initiation rates, an intervention that aims to lower smoking rates could improve both smoking and breastfeeding behaviors.

Telemedicine: With the increasing utilization of telemedicine throughout the United States, many states have begun integrating telemedicine into obstetrics and maternal health clinics. Access to telemedicine services could be an effective technique to improve maternal health outcomes for at-risk populations in rural areas such as many counties within the UFHPCA. Long driving times to reach physicians and limited options for perinatal care and digital information in rural counties may be detrimental to maternal health outcomes (37). In 2011, The Georgia Department of Public Health partnered with health districts and maternal medicine specialists to provide telemedicine consultations for African American and Hispanic women with high-risk pregnancies. In an 18-month period the preterm labor rate was reduced in the target population from 18.8% to 8% across 500 pregnancies. Additionally, there was a noticeable increase in the adherence to follow-up care following delivery (54). Telemedicine services allowed patients to communicate with their physicians via computers, phones, or tablets (55). Health interventions that leverage telemedicine have been associated with improvements in obstetrics outcomes (56). The limitations of UFHPCA regarding provider availability in maternity deserts highlight the need for innovative maternity care. Telemedicine could potentially bridge this gap in care but the limitation of computer access within the UFHPCA will prove another unique challenge.

Strengths and Limitations: The UFHPCA defines a region of North Central Florida. The strengths of using county rankings as a primary metric for comparison include ease of interpretation and visualization of unmet medical needs that can help generate active stakeholder participation in appropriate public health and policy actions. Because the data is systematically collected through existing state and federal agencies, the broader impact of interventions can be readily assessed with new data pulls. However, using existing county-level data limits the resolution of data that can be achieved. For example, while the available data allows us to count the number of licensed obstetrician gynecologists by county, it prevents us from capturing obstetric care offered by other providers (e.g. family medicine physicians who provide obstetric care, nurse practitioners, or midwives). Likewise, although we were able to compare rural and non-rural counties, such a binary designation may not capture local neighborhood effects. Given that the socioeconomic heterogeneity of rural areas has been documented (57), future studies on the UFHPCA should look beyond the binary rurality designation of each county and examine health outcomes related to poverty and other neighborhood demographic characteristics using census tract level investigations. Additionally, the only perinatal health behaviors measured were maternal smoking and breastfeeding initiation. Future studies could include a more comprehensive list of behaviors to provide a more descriptive picture. A higher resolution understanding of perinatal health outcomes and geographical locations of pediatricians, OB-GYNs, family practice physicians, and other perinatal care providers within the UFHPCA may help enhance understanding of the areas with the highest perinatal health burden and identify areas where public health initiatives would provide the most benefit. Alachua, location of UF Health Shands Hospital at the University of Florida, is the only county in the UFHPCA that is above the Florida rate for average numbers of pediatricians, OB-GYNs, and family practice physicians per

100,000 population. This further illustrates that UF Health Shands Hospital, the regional referral center for North Florida, serves an vulnerable population that often does not currently receive adequate care in their county of residence.

Conclusion

The results of this study highlight the importance of understanding the effects of SDoH on healthcare accessibility and perinatal outcomes in rural and non-rural counties within an accurate service catchment area. Delineating the boundaries of the UFHPCA allows researchers and providers to focus primary data collection and intervention implementation within an actionable region, facilitating collaborations with the appropriate non-profits and policy-makers to work towards the goal of addressing health disparities and communication inequalities. This paper therefore represents an essential first step towards launching interventions to address the impact of SDoH on perinatal health. These findings provide additional insight into prioritizing strategies that address SDoH and expand healthcare access to rural counties, such as improving healthcare access via telemedicine. By understanding how health behaviors and socioeconomic factors juxtapose with the physical environments in which patients live (i.e. rurality), the findings help identify potential policies and programs that may improve perinatal outcomes.

Abbreviations

- CHR: The County Health Rankings
- EHR: Electronic Health Records
- ER: Emergency Room
- NH: Non-Hispanic
- OB-GYN: Obstetricians and Gynecologists
- SDoH: Social Determinants of Health
- UF: University of Florida
- UFHPCA: The University of Florida Health Perinatal Catchment Area
- WIC: The Special Supplemental Nutrition Program for Women, Infants, and Children
- ZCTA: ZIP Code Tabulation Area

Declarations

Ethics approval and consent to participate

The EHR data for this study was approved by the Institutional Review Board of the University of Florida (IRB201601899).

Consent for publication

Not applicable.

Availability of data and materials

EHR data used in this study cannot be shared publicly in order to protect participant confidentiality. All requests to review data that may include potential subject and/or patient identifiers will be reviewed by our University's Privacy Office and Institutional Review Board to ensure adequate protection of subjects. Any dissemination approved by the University will be reviewed by a University honest data broker to ensure appropriate legal and ethical compliance with regulatory agencies. Requests for data should be addressed to Chris Harle at the University of Florida (charle@ufl.edu). County-level data on live birth rates, perinatal health data, and socioeconomic vulnerability metrics are publicly available from the Florida

Department of Health's FL Health Charts, [<http://www.flhealthcharts.com/Charts/MaternalAndChildHealth/default.aspx>]. The CHR's Health Outcomes z-scores are also publicly available, [<https://www.countyhealthrankings.org/explore-health-rankings/use-data>]. The R code used to create all maps and tables displayed in this study is available in the GitHub repo "mombaby-ehr-SdoH" [<https://github.com/lemaslab/mombaby-ehr-SdoH>].

Competing interests

Not applicable

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Authors' contributions

All authors designed research (project conception, development of overall research plan, and study oversight); CL and HB analyzed data and performed statistical analysis; DJL, JH, ML, and KX interpreted data findings; DJL, CL, HB, and KX drafted the initial manuscript; all authors provided critical revision of the manuscript; DJL and JH had primary responsibility for final content. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Figures

Figure 1

Rurality by Florida County and Associated County-Health Rankings Z-Scores.

Map of the rurality of 67 Florida counties according to Florida Statutes rurality designations with UFHPCA boundary outlined in black (left) and County Health Rankings Health Outcomes z-scores (right), where positive z-scores represent a greater health burden compared to the average of counties in Florida. Counties outside the UFHPCA are depicted as grey circles in the right. Only two of the thirteen catchment counties (Alachua and Lafayette) had higher health outcomes scores than the average of Florida counties, indicating that the UFHPCA as a whole has a higher health burden than the state. Three catchment counties (Union, Putnam, and Dixie) were in the top five highest health burden counties in Florida.

Figure 2

Rates of Preterm Births in Florida and the UFHPCA

Statewide map of preterm births with UF Health Perinatal Catchment Area (left; outlined in black). The thirteen catchment counties are ordered by rate where the statewide rate (10.1% from June 2011 - April 2017) is denoted by the vertical black line (right). Rates are weighted by county-level annual population. Within the UFHPCA ten out of thirteen counties had preterm birth rates above the statewide rate, indicating higher levels of health burden within the catchment.

Figure 3

Rates of Maternal Smoking during Pregnancy in Florida and the UFHPCA. Statewide map of the percent of births to mothers smoked during pregnancy with the UFHPCA (left; outlined in black) and the thirteen catchment counties ordered by smoking rate where the statewide rate (6.2% between June 2011 - April 2017) is denoted by the vertical black line (right). Rates are weighted by county-level annual population. All thirteen catchment counties had maternal smoking rates during pregnancy above the statewide rate.

Figure 4

Rates of Breastfeeding Initiation in Florida and the UFHPCA

Statewide map of county level breastfeeding initiation rates with the UFHPCA (left; outlined in black) and the thirteen catchment counties ordered by breastfeeding initiation rate where the statewide rate (82.9% between June 2011 - April 2017) is denoted by the vertical black line (right). Rates are weighted by county-level annual population. Within the catchment, all counties except Alachua County had rates below the statewide rate, indicating higher levels of health burden within the catchment.

Figure 5

Poverty Rate for Families with Children Under 5 in Florida and the UFHPCA

Statewide map of families with related children under the age of 5 living below the poverty rate with the UFHPCA (left; outlined in black). The thirteen catchment counties are ordered by rate where the statewide rate (17.5% from June 2011 - April 2017) is denoted by the vertical black line (right). Rates are weighted by county-level annual population. Within the UFHPCA all counties had poverty rates above the statewide rate, indicating higher levels of health burden within the catchment.

Figure 6

Rates of Access to Household Computing Devices in Florida and the UFHPCA in 2017

Statewide map of rates of computing device access within households in the UFHPCA (left; outlined in black). The thirteen catchment counties are ordered by household rates of access to one or more computing device, where the 2017 statewide rate (87.9%) is denoted by the vertical black line (right). Within the UFHPCA all counties except Alachua County had computing device access rates below the statewide rate, indicating higher levels of health burden within the catchment.

Supplementary Files

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