Predictors of preterm birth and low birth weight: A person-centered approach

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ABSTRACT

Objective: Profound disparities exist among Black and White families who experience adverse infant health outcomes, yet much is unclear regarding factors that predict disparate outcomes. In order to address this gap, this study applied a person-centered, intersectional analysis to determine ways that women's typological risk profiles inform risk for preterm birth and low birth weight.

Materials and methods: In order to examine the role that social determinants play in predicting risk, this study implemented a latent class mixture modeling analysis of data from the Pregnancy Risk Assessment Monitoring System (PRAMS). Data were extracted from Pennsylvania and Illinois PRAMS surveys from 2012 to 2015 ($n = 4336$).

Results: Results of the study indicate three distinct risk types among women in the sample: low-, moderate- and high-risk. Three latent classes were identified: (1) low risk for PTB/LBW (44%); (2) moderate risk (19%); and (3) high risk (36%). Compared to class one, the likelihood of experiencing PTB were significantly higher for class three ($x^2_{PTB} = 9.54$, $p < .001$; $x^2_{LBW} = 35.51$, $p < .001$). The likelihood of experiencing LBW were significantly higher for class three, compared to class two ($x^2_{PTB} = 9.21$, $p < .05$; $x^2_{LBW} = 21.17$, $p < .001$). Within the three risk groups, racial disparities are particularly notable, with 76% of the sample's African American mothers falling into the "high-risk" category.

Conclusion: Public and perinatal health researchers, organizations, and funders are increasingly recognizing the need to identify methods that will best support health-promoting interventions that have the potential to close the racial disparity in PTB and LBW. Although racial disparities have long been noted, the findings from this study's analysis help to better understand how determinants of health intersect to create an overarching risk profile, which can be used to inform health interventions and services that may reduce the current Black-White gap in infant health outcomes.

1. Introduction

The prevalence of preterm birth (PTB) and low birthweight (LBW) are markers of a healthy population, given the long-term implications of poor birth outcomes as well as their close association with infant mortality statistics. The United States (US), however, has some of the highest rates of poor perinatal outcomes among high income countries, despite having some of the costliest healthcare (Papanicolas et al., 2018). Although families from all racial and ethnic backgrounds experience PTB and LBW, Black families experience far greater rates of adverse birth outcomes, when compared to other racial and ethnic groups. Black infants are nearly twice as likely to be born preterm, compared to White infants (Manuck, 2017; Schaaf et al., 2013). Disparate rates of PTB and LBW create a ripple effect in subsequent wellbeing, influencing rates of

severe morbidity and mortality for mothers and children, alike (Anderson & Cacola, 2017; Ely & Driscoll, 2019; Rossen & Schoendorf, 2014). While numerous public health interventions have curbed the overall rates of PTB and LBW, not all US populations have been impacted equitably (Thomas et al., 2011). As a result, stark racial disparities in adverse perinatal outcomes persist (Goldfarb et al., 2018), and Black communities across the US continue to suffer a disproportionate burden related to childbirth and parenting.

Despite decades of research investigating PTB and LBW, much is still not known about why some populations experience greater rates of adverse outcomes than others (Manuck, 2017). Although the impetuses of disparate perinatal outcomes among Black and White families are poorly understood, existing research supports the influential roles of behavioral factors, interpersonal factors, and systemic/structural factors

(Manuck, 2017; Larson et al., 2017). Taken together, these diverse risk factors have contributed to the growing desire to implement "holistic" approaches to perinatal health research that can account for a larger proportion of influential health factors (Larson et al., 2017; Manuck, 2017; Maxson et al., 2016). Although enthusiasm for holistic analyses have been embraced conceptually within the perinatal health field, existing studies on racial disparities have largely been characterized by variable-centric approaches (Larson et al., 2017), that fail to capture the complexities of women's lived experiences and that have led to a "fundamental mismatch" (Bauer & Shanahan, 2007) between the field's predominantly linear analytic methods (such as regression analyses) and the desire to engage in person-centered work (Bauer & Shanahan, 2007). In order to enhance public health's capacity to further promote equitable perinatal health outcomes, research must reflect the vast heterogeneity among pregnant US women that contributes to variation in perinatal health outcomes.

2. Person-Centered Approaches to understanding adverse birth outcomes

One such way to analyze heterogeneous populations is through person-centered analyses. Person-centered work, which emphasizes the intersectional or dynamic nature of multiple individual characteristics (Lanza et al., 2011), demands a shift from analytical methods that are based on averages and are generalizable to a single, broad population to methodologies that examine trends based on subpopulations (Howard & Hoffman, 2018). While variable-centric analyses isolate variables to predict the likelihood of experiencing specific outcomes, person-centered analyses can better and more intuitively evaluate the ways that complex risk (Lanza et al., 2011; Shaw et al., 2019) shapes women's health experiences by calculating the likelihood of outcomes occurring based on the concurrent and dynamic influence of multiple predictive variables. Importantly, person-centered analytical strategies establish homogenous subgroups within which greater accuracy of risk prediction can be established, due to their ability to identify unique patterns of co-occurring risk (Shaw et al., 2019). Given the dynamic ways that individuals' social environments, interpersonal relationships, and individual biological and psychological health indicators interact with one another to shape health outcomes (Larson et al., 2017), person-centered analyses are a critical component to shaping future perinatal health promotion strategies (Shaw et al., 2019).

Despite the important contributions that person-centered analyses offer the field of perinatal health, few studies have integrated a multi-systemic, intersectional perspective for understanding how risk and protective factors concomitantly effect women's risk for experiencing PTB and having LBW babies (Coley & Nichols, 2016; Hendryx et al., 2014; Shaw et al., 2019). Further, there is a dire need for perinatal literature to explore PTB and LBW phenomena as they relate to the pervasive disparities between Black and White families. Among studies that have employed person-centered statistical analyses, there has been insufficient consideration allotted to the influence of women's race, which the National Institutes of Health (NIH) consider a fundamental component of advancing US health and wellbeing (NIH, 2021). As such, the aim of this study was to measure how characteristics of heterogeneous groups of women interact dynamically with one another to generate heterogeneous groups of women, to influence the probability of experiencing PTB and LBW. Thus, this study sought to answer the following research questions:

1) How do women's demographics and health indicators distinguish latent classes of women?
2) Will membership in classes comprised of higher risk women predict an increased likelihood of experiencing preterm birth?
3) Will membership in classes comprised of higher risk women predict an increased risk in low-birth weight infants?

4) Will membership in classes comprised of low-risk women predict a decreased likelihood of experiencing preterm birth?
5) Will membership in classes comprised of low-risk women predict a decreased risk of low-birth weight infants?

3. Theory

The current study utilized three theoretical frameworks (Critical Race Theory, intersectionality, and Ecosocial Theory) to create an overarching analysis of how social determinants of health interact in a dynamic way to predict which families are at the greatest risk of experiencing poor outcomes. Within this study, Critical Race Theory provided a framework for understanding the ways in which racism and discrimination shape the lives of persons of color (Delgado & Stefancic, 2001). Thus, the issue of race-based inequalities in the prevalence of PTB and LBW is recognized as a social issue, rooted in numerous discriminatory behaviors that have shaped differential exposure to privilege and oppression on the structural, interpersonal, and individual levels of society. Intersectionality was used to emphasize the complex ways in which various aspects of identity are enmeshed with one another (Murphy et al., 2009), and to provide an understanding through which structures of power and oppression generate resulting health outcomes for both expectant mothers and their infants. Although the author of this study considers racial discrimination to be a cornerstone through which disparate infant health outcomes are shaped, women's racial identities and their related lived experiences cannot be understood without also considering the dynamic role that other jointly occurring characteristics may play such as age, geographic location, income, and variation in insurance providers and subsequent coverage. Lastly, Ecosocial Theory acted as a third theoretical perspective through which this work was informed. Specifically, Ecosocial Theory highlights the pathways through which social determinants of health (SDH) are embodied and ultimately effect health outcomes (Krieger, 1994), such as rates of PTB and LBW. Ecosocial Theory implements a multi-systemic lens that provides an outlet for examining the shared role of structural determinants of health and individual determinants of health, respectively (Krieger, 2012).

4. Materials and methods

4.1. Study overview

This was a retrospective, cross-sectional study. Data for this study were extracted from the Pregnancy Risk Assessment Monitoring System (PRAMS). Maintained in partnership between individual US states and the Centers for Disease Control and Prevention, PRAMS is designed to track and assess population risks for poor perinatal outcomes (Shulman et al., 2018). PRAMS is based on a stratified random sampling technique to track health trends across diverse subpopulations of women. For additional information regarding PRAMS' data collection and management strategies please refer to work published by Shulman et al. (2018), which provides extensive information on existing PRAMS methodology.

Participants for this study were included from Pennsylvania and Illinois who responded to the PRAMS survey between the years 2012–2015 (N = 4336). Although data are available for a large proportion of US women, this study's theoretical framework necessitated the inclusion of a large number of variables that were not consistently available from all PRAMS-participating states, tribes, and cities during the 2012–2015 survey years. Only states that asked questions measuring all of the proposed study variables (i.e., Pennsylvania and Illinois) were included in the analysis. Participants from both states responded at similar rates, with recent response rates of approximately 66% from Illinois and 68% from Pennsylvania (Shulman et al., 2018). All data analyses were approved by the [Blinded for Review] University Institutional Review Board.

4.2. Measurement

Given the theoretical frameworks used to develop this analysis, women's intersectional identities were based on factors in three overarching categories: individual demographic characteristics, behavioral health factors, and physical health indicators. Indicators included within each category are based on available data provided by the Pennsylvania and Illinois PRAMS.

Demographics. Women's demographics included race (Black/White), marital status at time of conception (married/unmarried), age (>20 years, 20–24 years, 25–29 years, 30–34 years, and <34 years), education (less than high school education, high school education, some college, or college and beyond), income for the year prior to baby's birth (<$19,000; $19,001–22,000; $22,001–37,000; $37,001–52,000; $52,001–67,000; and >$67,000), and pregnancy insurance type (Medicaid/Other).

Behavioral health factors. Behavioral health factors included prenatal depression (yes/no); cigarette use during third trimester (yes/no); alcohol use during third trimester (yes/no); and prenatal care utilization (adequate; intermediate; and inadequate, based on the Kessner Index engagement classifications).

Physical health indicators. Physical health indicators during pregnancy included hypertension (yes/no); gestational diabetes (yes/no); and body mass index (underweight; normal weight; overweight; and obese).

Infant health outcomes. Infant health outcomes were defined as PTB and LBW. Both outcome variables were dichotomized, where PTB was operationalized as infants born before 37 completed gestational weeks and LBW was operationalized as infants with a birthweight less than 2500 g.

4.3. Analysis

This study implemented latent class mixture modeling (LCMM) to gain a more holistic, person-centered understanding of how women's lived experiences intersect to inform risk for adverse infant health outcomes. Among researchers who study intersectionality, LCMM is considered a beneficial analysis for understanding the ways in which key markers of identity effect a given individual's lived experience (Turan et al., 2019). LCMM is an analytic tool that allows researchers to calculate the probability of unique subgroups within a given population (Raveche Garnett et al., 2014), based on the cross-classification of two or more observed variables (Schreiber, 2017).

While methodologists offer several quantitative approaches that can be implemented in measuring intersectionality, using a latent class approach, as opposed to a regression model (even with interactions) has several advantages, including enhanced power and lower Type I error rates. Additionally, the use of latent classes can combat limitations associated with interpreting higher-order interactions. Lastly, given that LCMM allows for the identification of distinct, homogenous subgroups, this analytical approach offers the opportunity for enhanced predictive validity.

In LCMM, each subgroup in a given population is made up of approximately homogenous set of individuals with a unique set of characteristics that differentiates the group from other subgroups (Berlin et al., 2014). Although subgroups are rooted in an unobservable (latent) variable, they are formally organized based on response patterns to observable variables, known as manifest indicators (Raveche Garnett et al., 2014; Boel-Studt, 2014; Berlin et al., 2014) and can be measured via categorical or continuous data (Boel-Studt, 2014). In this particular analysis, participants' race, socioeconomic status, age, marital status,
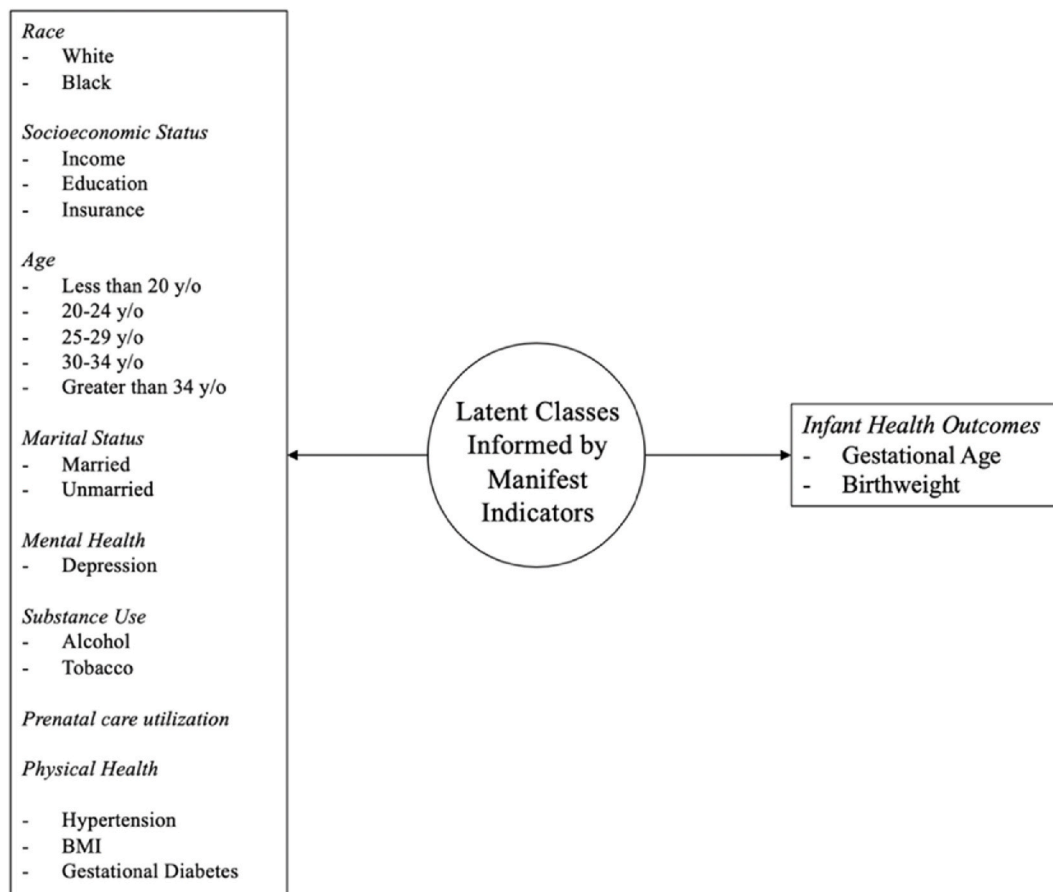

Fig. 1. Analytical model.

behavioral and physical health served as manifest indicators (see Fig. 1). Analyses were completed using SPSS and MPlus statistical software.

5. Results

5.1. Descriptives

Demographic characteristics. The final sample included 4336 newly postpartum women. Among mothers, approximately 85% ($n = 3702$) identified as White, and the other 15% of the sample identified as Black ($n = 634$). The majority of women were between 30 and 34 years old (31.6%; $n = 1369$), followed by women aged 25–29 (28.3%; $n = 1228$). Approximately one-third of the sample identified as unmarried (37.3%; $n = 1617$), and a large proportion of women indicated earning a household annual salary of less than $19,000 (22.9%; $n = 993$). Approximately one-third of women (36.3%; $n = 1573$) indicated receiving Medicaid benefits during pregnancy to help compensate for healthcare costs.

Behavioral health indicators. In examining women's experiences regarding perinatal behavioral health, approximately 8% ($n = 355$) of women endorsed being diagnosed with perinatal depression, a smaller proportion than the rate of perinatal depression expressed within the general population. Regarding perinatal substance use, 11.5% ($n = 498$) indicated that they smoked during their last trimester, while 7.7% ($n = 332$) of women indicated that they consumed alcohol during their last trimester. Lastly, while the majority of women (69.7%; $n = 3021$) indicated receiving adequate prenatal care, as determined via the Kessner Index, many still reported receiving either intermediate (17.1%; $n = 743$) or inadequate care (4.2%; $n = 184$), placing them at additional risk for experiencing subsequent poor physical and infant health outcomes (Partridge et al., 2012).

Physical health indicators. Most women in the sample indicated experiencing good physical health during pregnancy, as measured via women's rates of hypertension, gestational diabetes, and abnormal body mass indices (BMI). Less than 10% of women reported experiencing hypertension (8.9%; $n = 385$) and diabetes (9%; $n = 389$). Many women also reported a normal BMI (45.6%; $n = 1976$), though many also indicated being overweight (20.7%; $n = 897$) or obese (23%; $n = 996$), as measured via BMI.

Infant health outcomes. Given that PRAMS aims to oversample women at risk of PTB and LBW, it was expected that many of the women in the sample would report experiencing adverse infant health outcomes. Within the sample, 26.8% ($n = 1160$) of women reported giving birth to an infant who weighed less than 2,500g, while 20.1% ($n = 873$) of women reported giving birth prior to 37 completed gestational weeks.

5.2. Missing data

This analysis employed a FMIL method for addressing missing data, assuming that data are MAR. In order to assess for data MAR, data were examined bivariately, comparing differences between groups of participants across missing and non-missing data points. Given that data were determined to be MAR, a FMIL method was introduced to address the missing data points. FMIL, which has been deemed the most pragmatic method for addressing missing data in structural equation modeling, establishes a likelihood distribution for missing data based on individual's responses to the remaining completed variables (Newsom, 2018). Using this method rather than listwise deletion or mean-based methods of imputation limits the amount of error in the subsequent statistical analyses, thus enhancing the validity of the findings.

5.3. Inferential statistics

This study implemented a three-step LCMM approach to measure the effects of women's intersectional identities on perinatal health outcomes. Using this approach, (1) class enumeration was estimated, (2)

modal probabilities were assigned to each class, and (3) outcomes were added to the model to assess for classification error.

6. Latent class results

Model fit was evaluated for 2–4 classes using the Log Likelihood values (e.g., AIC, BIC, and ABIC), likelihood-based tests (e.g. VLRT/BLRT), as well as indicators of class separation (e.g., entropy values and posterior probabilities). A three-class model was determined to be the best fit, based on the manifest indicators included in the model (See Table 1), in combination with existing empirical and theoretical support related to the substantive differences between groups. Although the AIC, BIC, and ABIC values continued to decline with each increase in classes, indicating that an increase in classes better summarized trends in the data, the VLRT indicated support for a three-class model. Entropy and posterior probability values were each within their appropriate parameters for all three of the tested models but suggest that the discrepancy between a three-class model and a four-class model is limited, given their similar values. Model fit criterion for the automated three-step approach are summarized in Table 1 for additional clarity.

6.1. Automated modal class assignment

Within this set of analyses, modal class assignment was automatically calculated for the study's participants. Following the modal class assignment, logits were produced to account for measurement error that may have occurred. The resulting logits are included in Table 2.

6.2. Estimating the Final Mixture Model with fixed logits

In the third step of the automated latent-class analysis, the model was rerun using fixed logits to account for classification error. In addition to applying the fixed logits within the final model, PTB and LBW were introduced to the model as distal outcomes predicted by variations in the latent classes. In this stage of the analysis, class counts within the unconditional model from Step One and the Final Mixture Model produced in Step Three remained stable, indicating that the trends observed in the data are a result of the manifest indicators, rather than measurement error.

6.3. Summary of latent classes

Following the LCMM, each of the three classes identified within the analysis were assigned descriptive labels to clarify their defining characteristics. The classes were defined as *low-*, *moderate-*, and *high-risk* for poor infant health outcomes, based on the subgroups' primary identifying characteristics and their relation to perinatal risks in existing literature. Approximately 43% of the sample were characterized as low-risk; 21% as moderate risk; and 36% as high risk. The trends for each of the risk profile groups are illustrated in Fig. 2.

Women in the low-risk group (see green line in Fig. 2) had the greatest probability of being characterized by higher income, higher education, and self-identify as White, compared to the moderate- and high-risk mothers (also see Table 3 for a detailed summary of class comparisons). Notably, women in the low-risk group had a lower probability of identifying as very young, had a lower probability of being unmarried, and were less probable to report using Medicaid insurance, compared to the moderate- and high-risk group. In contrast, the high-risk group was characterized by women who had the greatest probability of identifying as Black, utilizing Medicaid insurance, and reporting lower annual incomes and educational backgrounds, compared to the low- and moderate-risk group of mothers.

Behavioral and physical health indicators provided additional insights into the risk profiles across the three latent classes. The low-risk class of women was generally characterized as a healthier group of women than those in the moderate- and high-risk classes. Here, women

Table 1
Summary of latent class model fit statistics for class enumeration.

Model	-Ln(L)	VLRT ($k - 1$)	P-value	AIC	BIC	ABIC	Entropy	Posterior Probabilities
2 class	−34993.55	−39397.08	<0.001	70089.11	70414.19	70252.13	0.92	0.976
3 class	−34625.04	−34993.55	<0.001	69404.08	69894.9	69650.22	0.82	0.813
4 class	−34448.53	−34625.04	1.00	69103.06	69759.61	69432.32	0.79	0.812

*Note: VLRT = Vuong-Lo-Mendell-Rubin Likelihood Ratio Test; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; ABIC = Adjusted Bayesian Information Criterion.

Table 2
Logit probabilities for the automated three-class model.

	Class 1	Class 2	Class 3
Modal #1	2.86	−5.11	−2.19

from low-risk backgrounds had a lower probability of experiencing depression and had a lower probability of engaging in poor perinatal health practices, such as perinatal smoking and the moderate/inadequate use of PNC, in comparison to women in the moderate-risk group. Women in the low-risk class also had a lower probability of experiencing gestational diabetes and high body mass index scores during pregnancy, when compared to women in the moderate-risk group. Conversely, women in the high-risk group had a lower probability of receiving adequate PNC compared to low- and moderate-risk groups and more likely to experience perinatal depression. Women in the high-risk group had a greater probability of falling in the low maternal BMI group. Likewise, women in the moderate-risk group had a lower probability of receiving adequate PNC compare to low-risk women and were more likely to experience perinatal depression compared to low-risk mothers. Interestingly, women in the moderate-risk category were at the greatest odds of smoking during the perinatal window and simultaneously had a greater probability of experiencing higher maternal BMI and to experience gestational diabetes and hypertension.

7. Latent classes and predicting infant health outcomes

The occurrence of preterm birth and low birth weight were included in the LCMM as distal outcomes, to test whether or not variation in the latent classes could predict statistically significant differences on the outcome variables. Within the LCMM, chi-square tests measured the relation between class membership and infant health outcomes (e.g., PTB and LBW). The overall model resulted in statistically significant differences in the conditional probabilities for both PTB ($x^2 = 12.77$, $p < .05$) and LBW ($x^2 = 39.58$, $p < .001$). There were also statistically significant differences in the likelihood of experiencing PTB and LBW when comparing the moderate- and high-risk groups ($x^2_{PTB} = 9.21$, $p < .05$; $x^2_{LBW} = 21.17$, $p < .001$; see Table 4 for individual class probabilities), as well as when comparing the low- and high-risk groups ($x^2_{PTB} = 9.54$, $p < .001$; $x^2_{LBW} = 35.51$, $p < .001$). No statistically significant differences were present between the low- and moderate risk groups, when examining the probability of experiencing PTB ($x^2 = 0.77$, $p = .38$) or giving birth to a LBW infant ($x^2 = 0.16$, $p = .69$).

8. Discussion

The purpose of this study was to evaluate the ways in which women's lived experiences interact to predict disparities in infant health outcomes, using a person-centered analytical approach. To date, few studies have explored women's intersectional identities to better understand risk for adverse infant health outcomes (Coley & Nichols, 2016; Hendryx et al., 2014; Shaw et al., 2019), which limits the capacity of culturally informed, research-supported health promotions and interventions. Further, of the studies that have implemented person-centered analyses within perinatal health, insufficient emphasis has been placed on mothers' race, despite sustained racial disparities in US perinatal health outcomes. In response to this knowledge gap, analyses were conducted to examine whether women's intersectional identities were able to
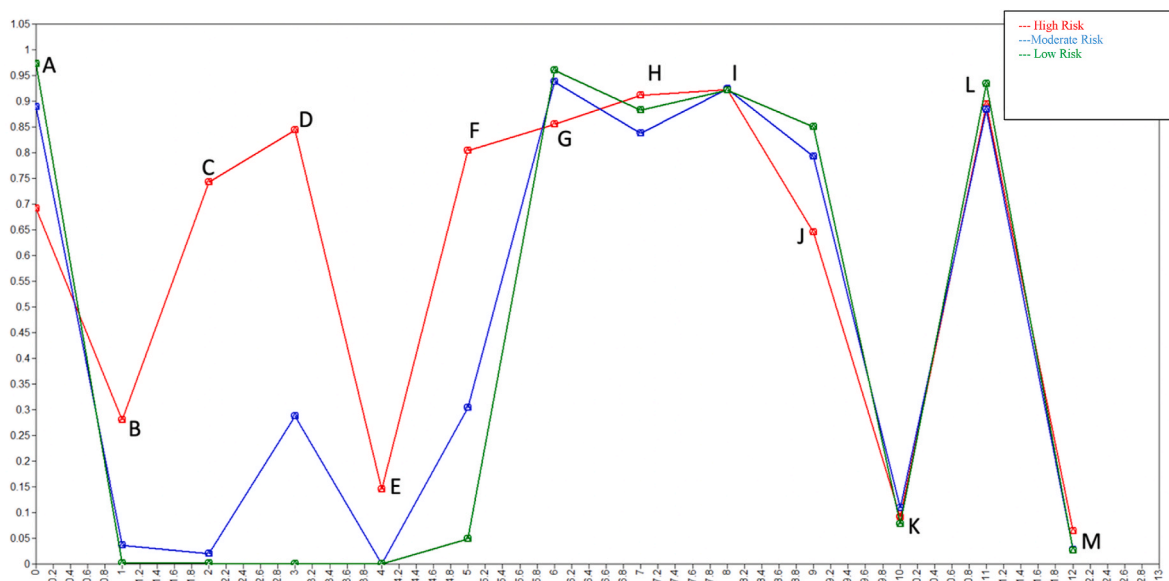

Fig. 2. *Risk profile comparisons*.
*Note-reference groups for the variables in the figure are as follows: (a) white ethnicity; (b) low education; (c) low income; (d) Medicaid recipients; (e) young maternal age; (f) unmarried; (g) not depressed; (h) no perinatal smoking; (i) no perinatal alcohol consumption; (j) adequate prenatal care utilization; (k) high blood pressure; (l) absence of gestational diabetes; (m) low maternal BMI.

Table 3
Conditional probabilities of risk and protective factors based on class membership.

	Class 1 (36%) High Risk	Class 2 (21%) Moderate Risk	Class 3 (43%) Low Risk
Race			
White	.69	.89	.97
Black	.31	.11	.03
Education			
Less than HS	.28	.04	0.001
HS	.38	.22	0.03
Some College	.31	.51	.15
College+	.03	.23	.82
Income			
<$19,000	.74	.02	0.001
$19,001–22,000	.15	.17	0.000
Income - continued			
$22,001–37,000	.07	.27	0.009
$37,001–52,000	.02	.27	.05
$52,001–67,000	0.004	.17	.1
>$67,001	.01	.09	.85
Insurance Type			
Medicaid	.84	.29	0.000
Other	.16	.71	1.00
Maternal Age			
<20 years	.15	0.00	0.000
20–24 years	.35	.19	0.01
25–29 years	.27	.38	.25
30–34 years	.16	.26	.47
<34 years	.08	.16	.27
Marital Status			
Unmarried	.80	.30	.05
Married	.20	.70	.95
Perinatal Depression			
No	.85	.94	.96
Yes	.15	.06	.04
Perinatal Smoking			
No	.91	.84	.88
Yes	.09	.16	.12
Prenatal Alcohol Consumption			
No	.92	.92	.92
Yes	.08	.08	.08
Prenatal Care Utilization			
Adequate	.65	.80	.85
Intermediate	.27	.18	.13
Inadequate	.09	.03	.02
Prenatal Hypertension			
Yes	.09	.11	.08
No	.91	.89	.92
Gestational Diabetes			
No	.89	.88	.93
Yes	.11	.12	.07
Body Mass Index			
Underweight	.06	.03	.03
Normal	.40	.42	.60
Overweight	.24	.24	.20
Obese	.30	.31	.18

Table 4
Conditional probabilities for each individual class.

Outcome	High-Risk Class	Moderate-Risk Class	Low-Risk Class
Preterm birth	0.26 [a,b]	0.19[a]	0.21 [b]
Low birth weight	0.34[a,b]	0.23[a]	0.24[b]

a = statistically significant difference at $p < .001$.
b = statistically significant difference at $p < .001$.

predict the likelihood of experiencing PTB and LBW. LCMM was applied to assess the ways in which the intersection of women's demographics and health indicators created distinguishing classes. The LCMM was subsequently used to determine the probability of experiencing adverse infant health outcomes, given women's class membership.

Within the analyses, three subtypes of women were identified-each distinguished by the hypothesized degree of risk for PTB and LBW (i.

e., low-, moderate-, and high-risk). The classification of women's risk factors by severity has important implications for the dynamic relation between risks, beyond interpreting each individual risk factor independently of its counterparts. As such, women with a greater proportion and higher severity of risk factors were hypothesized to be high risk of experiencing PTB and LBW, while women with fewer and less severe risk factors were hypothesized to be low risk. Latent classes with greater proportions of Black mothers are considered to be at a greater risk of adverse outcomes, for example, given the number of structural, interpersonal, and individual factors that inform inequitable health outcomes, as informed by CRT. Intersectionality and the ecosocial model further informed women's risk and protective factors. Thus, women's degree of perinatal risk was further determined based on the dynamic interplay of additional demographic factors, behavioral health indicators, and physical health indicators. Women who self-identified as unmarried, with poor behavioral health, and poorer physical health were considered higher risk than women who identify as married, with positive behavioral health practices and optimal physical health statuses.

8.1. Racial identity and risk

Women of color are disproportionately likely to experience poor outcomes as a result of their regular exposure to chronic stress and resource accessibility, in relation to historical and ongoing racial discrimination and stigmatization (Alhusen et al., 2016). Results from the analysis indicate support for the prominent and distinguishing role that women's self-identified racial identities play in determining subtypes of women. Within the three latent classes, the low-risk group consisted almost entirely of White women (97% White), while the high-risk group had a considerably larger proportion of women who identified as Black (31% of this class identified as Black, but this proportion accounted for approximately 76% of the total number of Black women in the study's sample). While mothers' racial backgrounds played an influential role in distinguishing risk profiles, existing theoretical and empirical literature suggests that it is important to additionally examine characteristics from an intersectional perspective, in order to best understand how women's characteristics informed their complex risk for PTB and LBW (Coley & Nichols, 2016; Larson et al., 2017; Murphy et al., 2009).

8.2. Intersectional identities and risk

This study hypothesized that additional marginalizations, particularly as they relate to income, educational attainment, insurance type, and marital status would further enhance the probability of adverse outcomes. Women who earn lower incomes, who have more limited educational attainments, and who are reliant on Medicaid insurance may be additionally exposed to adverse stress, given challenges related to accessing appropriate housing, nutritional foods, and healthcare resources. These stressors may be further augmented in women who are not married, if they do not have a partner to navigate challenges with. Many of the findings from this analysis paralleled trends in the extant literature (e.g., Hendryx et al., 2014; Shaw et al., 2019). Within this study, "high-risk" women were most likely to earn very low incomes, were more likely to have a high school degree or less, and were more likely to self-identify as Medicaid recipients, and were less likely to be married compared to low- and moderate-risk women.

Although race, SES, and risk have a clear relation, existing intersectional literature provides equivocal support for an association between maternal age and subsequent adverse birth outcomes (Schempf et al., 2007). Rather than a linear relation between age and risk, previous research shows a curvilinear relation (Schempf et al., 2007), with young maternal age being disproportionately associated with risk for poor outcomes among White women, particularly in relation to very and extremely PTB (Schempf et al., 2007). Findings from the current study

reflect trends in the existing literature linking the intersection of young maternal age and race to variation in the risk of adverse infant health outcomes. Within the present study, approximately 15% of women in the high-risk group self-identified as adolescent mothers, compared to less than 1% of women in the moderate- and low-risk groups. Importantly, while the high-risk class of women consists of the greatest proportion of Black mothers, nearly 70% of women in this class self-identify as White, highlighting the fact that the young, White mothers in this group are at an augmented risk for adverse outcomes.

Although advanced maternal age (AMA; greater than 34 years of age) is a documented risk for PTB and LBW, this trend was not reflected in this study's findings. In fact, women who identified with AMA were most likely to fall into the "low-risk" group of women within this analysis. It is important to note that maternal age in-and-of-itself may not be a good indicator of risk, but rather, may be a proxy for risk factors that influence women's ability to access critical resources within their communities, such as SES and social supports (Schempf et al., 2007). Although more in-depth analyses are required for future research, this study's findings regarding the relation between maternal age and risk for adverse outcomes could indicate that resource accessibility issues that young mothers encounter play a greater role in predicting disparate outcomes, compared to the medical and biological indicators associated with AMA.

8.3. Maternal health and risk

Intersectional identities that reflect greater degrees of structural inequity may subsequently enhance risk of greater degrees of adverse prenatal health, which in turn affect risk for PTB and LBW (Berg et al., 2010; Goldenberg et al., 2008). Given this, the present study hypothesized that women's behavioral and physical health statuses work dynamically with one another and with the previously addressed demographic factors. Study findings support this hypothesis. For example, "low-risk" mothers had the lowest probability of having been diagnosed with depression, or to receiving inadequate PNC. Women in the low-risk group also had a greater probability of experiencing positive physical perinatal health outcomes, in that they had a lower probability of experiencing gestational diabetes and obesity than other latent classes of women. Taken in combination, these outcomes suggest that the social privilege experienced by women in this group may help to protect against poor behavioral health.

Conversely, women in the high-risk group had the greatest probability of identifying with being young, unmarried, and low-income. Women in this class also had the greatest probability of having been diagnosed with prenatal depression and the lowest probability of adequately utilizing PNC. Interestingly, women in the high-risk group had the greatest probability of having been diagnosed with depression during their pregnancies, despite their lower probability of receiving adequate PNC. This is likely due to their enhanced risk. Although women in this subgroup are already being diagnosed with depression at greater rates than women in the moderate- and low-risk groups, they are still likely being underdiagnosed, given that prenatal depression has been coined the "most underdiagnosed pregnancy complication in the US" (Earls, 2010, p. 1032), and that this group of women is the most likely to underutilize PNC, where mental health concerns like depression could be addressed.

High-risk women had a similar probability of experiencing prenatal hypertension compared to women in the low- and moderate-risk groups, suggesting that hypertension may not be the most salient variable in the LCMM. Notably, research has connected the risk for hypertension with chronic life stress (Sparrenberger et al., 2009), which is in conflict with this study's findings. Although previous studies have suggested women accurately report perinatal health experiences in retrospective study designs (e.g., Rice et al., 2007), the findings in this study related to women's hypertension may have been affected by inaccurate reporting, as women may not have consistently been aware of their hypertensive statuses. Furthermore, if women are receiving less-than-adequate

degrees of PNC, they may be less likely to be diagnosed with hypertension, despite their hypertensive statuses.

Many of the high-risk group's distinguishing characteristics align with an increased probability of experiencing PTB and LBW, however, women in this class had an equal probability of consuming alcohol during the prenatal period and a smaller probability of engaging in prenatal smoking behaviors than women in the low- and moderate-risk groups. This finding does not align with the theoretical frameworks in this study (i.e. the experience of increased stressors coincides with the increased likelihood of risky substance use behaviors).

The dichotomy within the high-risk class of greater psychosocial risks and a lower probability of perinatal cigarette use may provide an interesting insight into the intersection of risk and protective factors that is not well understood and that will require further investigation. Interestingly, although women in the moderate-risk group are more likely to engage in risky perinatal health behaviors, they are still more likely to utilize PNC compared to women in the high-risk group. While the results of this study do not explain the relation between cigarette use and overall risk for PTB and LBW, one possible explanation may be that the access to care and other social resources available to women in the moderate and low risk groups may have a great enough protective effect that it buffers the risk associated with poor perinatal behavioral health practices. Other related perinatal health equity research suggests that site of perinatal care may influence health outcomes, as well. Howell's and colleagues' (2016) research on maternal morbidity, for example, found that women who gave birth in predominantly Black-serving hospitals had a greater likelihood of experiencing severe morbidity than those who gave birth in predominantly White-serving hospitals. This research found that predominantly Black-serving hospitals were more likely to be located in an urban area, be housed in the South, serve a higher number of Medicaid patients, provide teaching opportunities for healthcare students, and serve a larger number of patients, but that disparities in outcomes persisted even after controlling for risk factors (Howell et al., 2016). It is possible that similar trends are at play within this study, however, it was not possible to measure this hypothesis within the current study. Lastly, because LCMM is a data-driven technique, it is possible that the associations seen in this analysis may be due to the specific nature of the PRAMS participants.

8.4. Risk profiles and the experience of preterm birth and low birth weight

Despite this study's equivocal findings related to the risk and protective factors among women in the low-, moderate-, and high-risk groups, it is important to understand how each group's distinguishing characteristics inform their probability of experiencing PTB and LBW. Analyses indicated an increased probability of experiencing both PTB and LBW among women with higher-risk profiles. For example, when compared to moderate-risk women, the high-risk women were more likely to experience PTB and LBW. Likewise, when compared to low-risk women, high-risk women were more likely to experience PTB and LBW. There were no statistically significant differences between women in the moderate- and low-risk groups for both PTB and LBW. Given that women in the high-risk group were the most resource-constrained group of women in the LCMM, this may suggest that women's ability to navigate their social environments may inform their risk for adverse health outcomes. According to the study's theoretical frameworks, when women are unable to successfully navigate their social environments to meet their needs, they may be at an increased risk of experiencing adverse maternal and infant health outcomes. As such, women who are unable to access necessary resources experience an augmented risk for poor outcomes. Likewise, differences in birth outcomes among women in low- and moderate-risk groups may have been more limited in nature, given that they were theoretically better able to navigate their social environments. It is also possible that unobservable differences between groups, such as resiliency, may explain why there is not a statistically significant difference in birth outcomes between the moderate- and low-

risk groups. Future research should explore this in further detail. Despite the fact that no statistically significant differences were present between the probability of PTB and LBW between low- and moderate-risk groups of women, the model still resulted in substantively different categories of women, which may infer that strategies for perinatal care provision should vary, in order to provide optimal perinatal care for a broad group of pregnant women. Future research may investigate the care preferences of women with similar characteristics to those in this study's subgroups.

8.5. Limitations

Importantly, results and implications from this study must be considered within the context of its limitations. First, although PRAMS data as a whole are considered nationally representative, results of this study are not weighted and are specific to the states of Pennsylvania and Illinois. Unfortunately, very few participating PRAMS states survey participants on each of the study variables, and analyses could not be expanded to include additional states, cities, or tribes. Given the limited numbers of Native American participants within the states of Pennsylvania and Illinois for the study's survey years, there was insufficient data to report on Native American women's experiences, and thus these respondents are not included in the analysis. This limitation is not uncommon within perinatal health studies, but unfortunately, insufficient empirical representation can further perpetuate the poor outcomes experienced among Native populations. Thus, findings from this study have limited generalizability, given the study's sample and methodology,.

Additionally, PRAMS questionnaires also rely on participant recall, which is an additional limitation of this data. Participant recall has the potential to impact the internal validity of the analyses, particularly during life stages where a large degree of change happens in a short period of time. Selection bias should also be considered when examining the integrity of the data's internal validity. Given that women elect to participate in the PRAMS study, the sample may over represent mothers with positive postpartum experiences. That is, women with the greatest behavioral health needs may be less likely to respond to the questionnaire, as they are already confronted with a number of important hurdles in their personal lives.

Lastly, some mothers may be increasingly likely to misreport their pregnancy and birth experiences, due to the many stigmas surrounding health behaviors and mental health experiences during the perinatal window. Although validation studies indicate women generally recall and report pregnancy, childbirth, and postpartum information accurately (e.g., Rice et al., 2007), it is important to consider the role that fear of judgement or punishment may play in women's reporting. If women fear that their responses may put them at risk of contact with child protective services, they may be less likely to respond accurately or entirely to the PRAMS survey.

9. Implications

9.1. Research implications

Results related to the intersection of women's demographic risk factors, mental health experiences, and PNC utilization appear to have the greatest role in distinguishing unique classes of women compared to women's physical health and substance use indicators, given the degree to which these characteristics are differentiated across subtypes of women. As such, demographic risk factors, mental health experiences, and PNC utilization play an important role in predicting women's probability of experiencing PTB and LBW. Because variables related to accessibility of resources are some of the predominant distinguishing characteristics across the classes, it may be important to take a longitudinal approach to evaluating women's health needs moving forward, as issues of class and race cannot be confined to a single life stage. By

taking a longitudinal approach to women's health, researchers have the potential to further affirm the importance of the ecosocial perspective, where the dynamic interplay of exposure, susceptibility, and resistance play an important role across women's lived experiences as a whole (Halfon et al., 2014; Krieger, 2012). Further, in addition to acknowledging the importance of women's intersectional identities, all future investigations into the racial disparities of PTB and LBW are strongly urged to implement a critical race framework to challenge the powerful ways in which structural and interpersonal discrimination create a perpetual cycle of social disadvantage and in turn, impacts perinatal health. Lastly, this study's equivocal findings require additional exploration in order to best understand how they are informed by women's social contexts, particularly in relation to women's age and behavioral health statuses. For example, future studies should seek out examples of resilience within communities that may inform deviation from previously established relations between individual characteristics and the likelihood of experiencing perinatal adversity.

9.2. Practice implications

This study provides evidence of the influential relation between women's race and their social experience and subsequent health outcomes. Results of this study have important implications for interdisciplinary health professionals, including social workers, nurses, physicians, and other public health professionals. First, perinatal care students and providers, alike, should be trained on relationship-centered, anti-racist care that is characterized by a desire for cultural humility and an overarching respect for the lived experiences that shape health disparities (Hardeman et al., 2020; Rent, 2021). Within this method of care delivery, providers are seen as experts in women's physical and behavioral health, while patients are viewed as the experts in their own health experiences and preferences (Beach et al., 2006; Hardeman et al., 2020). By implementing a relationship-focused care strategy, providers work collaboratively with patients to identify health needs, barriers to addressing health needs, and solutions for achieving optimal health outcomes, while simultaneously providing emotional support for patients as they undergo a monumental life change (Beach et al., 2006; Hardeman et al., 2020). Through this care strategy, providers can help to disrupt systemic and interpersonal inequities that Black women may otherwise be confronted with during their perinatal care.

Health navigators and community health workers can also implement strategies for empowering patients. For instance, navigators can help to address a wide scope of SDH by working in collaboration with women to develop strategies to empower women to seek the resources they feel are necessary to promote their wellbeing and the wellbeing of their families. Additionally, health navigators and community health workers can connect with women to identify and address pressing needs, such as accessing health insurance and developing transportation plans and childcare to allow for PNC.

The support of health navigators and community health workers may be especially valuable for women whose characteristics align with those in the study's high-risk group, particularly related to the high proportion of Medicaid recipients within the group. Often, PNC utilization is delayed among women who use Medicaid during their pregnancies, as they must provide proof of pregnancy and then subsequently wait to be added to Medicaid insurance prior to receiving insurance coverage for care. If women are simultaneously earning low-incomes, health care may be difficult to afford if they do not apply for insurance quickly. Similarly, childcare and transportation are likely barriers that have the greatest impact among women in the high-risk group. If women are living on very low annual salaries, it may be challenging to access care due to inefficient transportation systems and unobtainable supervision for children already in their care.

Although some literature has been critical of the effectiveness of PNC on reducing the likelihood of experiencing PTB and LBW (i.e., Lu et al.,

2003; Braveman & Gottlieb, 2014), it is important to access care, particularly among women who are more likely to experience prenatal depression. If women are unable to access care, they may not receive necessary care for emergent mental health concerns. As such, it is important that women are able to access necessary primary care services during pregnancy, in addition to the specialty mental health care that they may need if they are experiencing adverse mental health.

In addition to connecting women with PNC, health navigators have also been shown to help patients access social services that may be of benefit to them (Valaitis et al., 2017). Social service support can help to provide a more holistic approach to care for women who are experiencing complex care needs that cannot be addressed within the confines of a short PNC visit. Notably, while increased access to PNC, alone, has not historically and uniformly benefitted underserved populations, increases in social supports have been identified as a promising approach to enhancing health outcomes (Braveman & Gottlieb, 2014). By integrating health navigators into existing care strategies, women are better able to receive care that is comprehensive and that addresses the many SDH that have the ability to profoundly impact perinatal health outcomes (Perez & Martinez, 2008). Thus, through their efforts to connect women with health and social services, these health workers play an essential role in promoting the economic, social, environmental, and political rights of patients in traditionally underserved populations (Perez & Martinez, 2008). Via this role, health navigators and community health workers can contribute to the much-needed reduction in the persistent and pervasive racial disparities in PTB and LBW.

9.3. Policy implications

This study's findings reaffirm the pervasive nature of race-based perinatal health disparities. In the current US social context in which Black persons are routinely marginalized and oppressed, poor health outcomes, including perinatal adversities, grow increasingly likely and point toward the urgent need for policies that promote equity across local, state, and national communities. In order to shift perinatal health outcomes to a state of equity, policies that "remove obstacles such as discrimination, poverty, and lack of access to quality education, housing and healthcare" (Stevenson et al., 2020, p. 192) are of critical importance.

Findings from this study provide key information related to US health policies, particularly in relation to healthcare accessibility and affordability. Policies that incentivize quality care at hospitals providing perinatal services to predominantly Black communities may help to mitigate disparate and poor perinatal health outcomes (Howell & Zeitlin, 2017). Additionally, incentivizing health outcomes through value-based service reimbursement, rather than fee-for-service reimbursement models, may help to eliminate some racial disparities in perinatal health (De Jonge et al., 2019). By prioritizing policies that promote accessibility of quality care delivery, we can make strides toward eliminating structural barriers to healthy perinatal outcomes.

Lastly, policies that focus on maximizing the affordability of perinatal care services, such as Medicaid Expansion, should be enhanced and prioritized. Part of the Affordable Care Act (2014), Medicaid Expansion allows for greater access to key perinatal health services for women who may not otherwise be able to afford healthcare, such as preconceptive care, prenatal health screens, prenatal depression screenings and subsequent treatment, and tobacco cessation supports (Searing & Cohen Ross, 2019). Because Medicaid provides perinatal healthcare coverage to some of the country's poorest mothers, expanding coverage has potential to proactively address risks and enhance optimal outcomes among mothers who would otherwise have been apt to underutilize preconceptive, prenatal, and other perinatal care resources. Given this, health policy researchers have indicated that Medicaid Expansion is a critical method for mitigating disparities in maternal and infant health outcomes (Searing & Cohen Ross, 2019; Brown et al., 2019), with some indicating that Medicaid Expansion may be "among the most important ways to improve maternal child health indicators" (Bhatt & Beck-Segue, 2018, pp. 525).

Notably, Pennsylvania and Illinois both currently participate in Medicaid Expansion (Searing & Cohen Ross, 2019). By expanding their eligibility criteria, it is possible that disparate outcomes are partially mitigated as a result of increased health resource accessibility during the perinatal period, given that the rate of uninsured women of childbearing age falls below the national average (21%) for both states (Illinois = 17.2%, Pennsylvania = 13.9%; Searing & Cohen Ross, 2019). Future studies should investigate the relation between the dynamic intersection of SDH, Medicaid Expansion, and racial disparities in adverse infant health outcomes, in order to strengthen our understanding of the ways in which Medicaid Expansion may help to buffer underserved families from poor outcomes.

10. Conclusions

Results of this study provide evidence for the important role that women's intersectional identities play in understanding risk for adverse perinatal health outcomes. Although racial disparities have long been noted, the findings from this study's intersectional analysis help to better understand how women's demographic characteristics and lived experiences intersect to create an overarching risk profile. Findings from this study can be used to inform potential clinical and policy-driven strategies for perinatal health promotion that can help move the needle on the current gap in infant health outcomes.

Author statement

This manuscript is sole-authored, and as such, all work presented in this submission was conducted independently by the author.

Ethical statement

This paper, *Predictors of Preterm Birth and Low Birth Weight: A Person-Centered Approach*, is being submitted for review with Social Science Medicine. The article is solely under review with SSM. The author has no financial declarations or conflicts of interest which apply to this article.

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