

Clemson University

TigerPrints

All Dissertations

Dissertations

5-2023

Influences on Pregnancy: An Exploration of Maternal Discrimination, an Alternative Model of Prenatal Care and Health Information Online

Emily Doherty
eadoher@g.clemson.edu

Follow this and additional works at: https://tigerprints.clemson.edu/all_dissertations



Part of the [Maternal and Child Health Commons](#)

Recommended Citation

Doherty, Emily, "Influences on Pregnancy: An Exploration of Maternal Discrimination, an Alternative Model of Prenatal Care and Health Information Online" (2023). *All Dissertations*. 3300.

https://tigerprints.clemson.edu/all_dissertations/3300

This Dissertation is brought to you for free and open access by the Dissertations at TigerPrints. It has been accepted for inclusion in All Dissertations by an authorized administrator of TigerPrints. For more information, please contact kokeefe@clemson.edu.

INFLUENCES ON PREGNANCY:
AN EXPLORATION OF MATERNAL DISCRIMINATION, AN ALTERNATIVE MODEL
OF PRENATAL CARE AND HEALTH INFORMATION ONLINE

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Applied Health Research and Evaluation

by
Emily Ann Doherty
May 2023

Accepted by:
Sarah Griffin, PhD, MPH, Committee Co-Chair
Kathleen Cartmell, PhD, MPH, Co-chair
Moonseong Heo, PhD
Amy Crockett, MD

ABSTRACT

In the United States metrics of perinatal health lag far behind peer countries and is characterized by stark disparities. The studies that make up this dissertation seek to elucidate factors influencing perinatal health.

The first and second chapters provide an introduction and extensive review of the literature of factors contributing to perinatal health with specific focus on discrimination and perinatal health; group prenatal care and digital pregnancy health information. The third chapter introduces the methodology to be used by each of the following studies. Subsequent chapters are formatted as individual manuscripts, each presenting background, methodology, results, and discussion.

The fourth chapter (Manuscript 1) sought to explore pregnant persons intersectional experience of discrimination and the association with adverse perinatal health outcomes. This study was a secondary analysis of data collected in a randomized controlled trial of pregnant persons at a single practice (CRADLE study). Latent class analysis was used to identify distinct subgroups of discrimination experience based on patterns of response to Everyday Discrimination Scale items and between subgroup differences in rate of adverse perinatal health outcomes examined utilizing a BCH three-step approach. Four discrimination subgroups were identified among racial and ethnic groups. The general discrimination latent class was associated with elevated risk of postpartum depression symptoms (among Black and White participants) and low infant birthweight (among White participants) relative to the no discrimination latent class. No significant subgroup differences were observed among Hispanic participants. Findings

demonstrate the importance of intersectional discrimination exposure in shaping perinatal health.

The fifth chapter (Manuscript 2) applied a concurrent mixed methods approach in the examination of patient characteristics associated with group prenatal care and the exploration of patient experiences in group compared to individual prenatal care. This study was a secondary analysis of data collected in the CRADLE study, as well as patient interviews collected in a coordinated process evaluation. The association of patient sociodemographic, psychosocial and health characteristics with group prenatal care session attendance were examined using zero-inflated poisson regression models.

Thematic analysis of patient interviews was conducted. Varied patient characteristics were found to be associated with session attendance. Group prenatal care was identified to offer alternative opportunities for education, engagement, and peer support. Findings offer insight into model modifications, recruitment, and retention strategies.

The sixth chapter (Manuscript 3) utilized topic modeling to describe topics of discussion in online pregnancy forums. Data was gathered from three active online pregnancy forums for a one-year period. Discussion threads were processed, converted to a document term matrix and Latent Dirichlet Allocation performed. Forty-six percent of threads were determined to be health related. The largest health-related topic categories included fertility, planning for delivery, miscarriage and pregnancy symptoms. Findings offer insight into dominant health related topics being discussed among online peer communities, potentially reflecting unmet information needs during pregnancy.

ACKNOWLEDGMENTS

It truly takes a village. So many people helped me to complete this dissertation. I would like to offer a special thanks to my dissertation chairs, committee, parents, sister, family friends and colleges that made this document possible either through direct assistance or support.

TABLE OF CONTENTS

	Page
TITLE PAGE	i
ABSTRACT	ii
ACKNOWLEDGMENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	x
CHAPTER	
I. INTRODUCTION	1
Perinatal Health in the United States	1
Dissertation Purpose	2
Dissertation Aims.....	7
Dissertation Organization	8
References.....	9
II. LITERATURE REVIEW	14
Chapter Overview	14
The State of Perinatal Health	14
Discrimination and Perinatal Health (Manuscript One)	23
An Alternative Model of Prenatal Care (Manuscript Two)	35
Health Information Online During Pregnancy (Manuscript Three)	52
Dissertation Studies	61
References.....	63
Tables and Figures	84
III. METHODOLOGY	120
Research Questions.....	120
Centering and Racial Disparities Trial.....	121
CRADLE Study Process Evaluation.....	122
Manuscript One.....	123
Manuscript Two	125
Manuscript Three	127
References.....	130

TABLE OF CONTENTS (Continued)

	Page
Tables and Figures	132
IV. MANUSCRIPT ONE.....	133
Abstract	133
Introduction.....	134
Methods.....	135
Results.....	139
Discussion.....	144
Conclusion	149
References.....	150
Tables and Figures	153
V. MANUSCRIPT TWO.....	159
Abstract	159
Introduction.....	160
Methods.....	163
Quantitative Results	169
Qualitative Results	172
Integration	178
Discussion.....	179
Conclusion	183
References.....	185
Tables and Figures	188
VI. MANUSCRIPT THREE.....	200
Abstract	200
Introduction.....	201
Methods.....	204
Results.....	206
Discussion.....	209
Conclusion	215
References.....	216
Tables and Figures	220
VII. DISCUSSION.....	225
Summary of Findings.....	225

TABLE OF CONTENTS (Continued)

	Page
Strengths and Limitations	228
Implications and Future Directions.....	231
References.....	237

LIST OF TABLES

Table	Page
2.1 Primary outcomes in studies of discrimination and perinatal health.....	84
2.2 Studies investigating discrimination and gestational age at birth	85
2.3 Studies investigating discrimination and infant birthweight or size	88
2.4 Studies investigating discrimination and maternal health outcomes	91
2.5 Primary outcomes examined in randomized controlled trials of group prenatal care	95
2.6 Randomized control trials of group prenatal care in the US.....	97
2.7 Characteristics of randomized control trials of group prenatal care outside the US	100
2.8 Observational studies examining group prenatal care	104
2.9 Studies examining characteristics associated with interest or participation in group prenatal care	106
2.10 Studies examining online pregnancy forums through analysis of posts	109
3.1 Summary of methodology.....	132
4.1 Frequency of sociodemographic characteristics, everyday discrimination and adverse perinatal health outcomes	153
4.2 Fit indices for latent classes of maternal discrimination in the overall sample and among Black, Hispanic, and White	155
4.3 Item-response probabilities for four-class models of maternal discrimination	156

LIST OF TABLES (Continued)

Table	Page
4.4 Estimated proportions of adverse perinatal health outcomes by latent class.....	157
4.5 Difference in log odds estimations of proportions of outcomes by latent class.....	158
5.1 Characteristics of patients assigned to group prenatal care	190
5.2 Count model: likelihood of group prenatal care session attendance.....	193
5.3 Zero inflated model: likelihood of attending zero sessions	195
5.4 Number and trimester of qualitative interviews.....	198
5.5 Sociodemographic Characteristics of Interview Participants	198
5.6 Interview participant prenatal care attendance	198
6.1 Summary of topic words, topic labels and categories in online pregnancy forums.....	220

LIST OF FIGURES

Figure		Page
2.1	Intersectionality perspective of discrimination framework	118
2.2	CenteringPregnancy essential elements and content	118
5.1	Essential elements of effective CenteringPregnancy and discussion topics.....	189
5.2	Abbreviated semi-structured interview guide questions.....	189
5.3	Participant session attendance and proportion eligible.....	193
5.4	Depiction of themes by model of care	199
6.1	Process of analysis	220
6.2	Prevalence of health and non-health related topics in online pregnancy forums.....	223
6.3	Health-related topics and patient education in perinatal care	224

CHAPTER ONE

INTRODUCTION

Perinatal Health in the United States

Measurement of infant and maternal death is a key component of perinatal health surveillance, related to maternal, fetal, and infant health and wellbeing. Infant mortality rate (IMR) a measurement of infant deaths prior to their first birthday and maternal mortality rate (MMR) a measurement of death due to complications from pregnancy or childbirth. IMR and MMR considered primary indicators of overall population health and health care delivery quality.¹ Over the past decades IMR in the United States (US) has improved, declining 17% since 2005.² In 2020, the US's IMR reached a new low of 5.4 infant deaths per 1,000 live births.³ Despite this improvement, the IMR in the US continues to lag far behind other developed nations, ranking 34th out of the 44 Organization of Economic Co-operation and Development (OECD) countries.⁴ Over this same period, US MMR has not seen a similar decline. Since the pregnancy mortality surveillance systems inception in 1987, the MMR has steadily risen, increasing 58% since 1990.^{5,6} In 2020, MMR in the US was 23.8 deaths per 100,000 live births.⁷ In a comparison by the Commonwealth Fund, MMR in the US was found to be double that of the ten high-income countries in which it was compared.⁸

Infant and maternal mortality in the US is characterized by large racial and ethnic inequities, that have persisted, widening over time.^{9,10} While IMR has declined across all races, infants of non-Hispanic Black birthing persons die at twice the rate of infants of non-Hispanic white birthing persons.¹¹ The MMR of Non-Hispanic Black birthing persons is three times that of non-Hispanic white birthing persons.⁷ Despite significant investment, IMR and MMR in the US remains unacceptably high, with the burden of loss disproportionately affecting Black birthing

persons and infants. There is a need for research to advance our understanding of the complex issues contributing to the US's relatively poor perinatal health and to generate effective interventions to decrease health disparities and reduce infant and maternal mortality rates to a level similar to those reported in peer countries.

Dissertation Purpose

The empirical studies that make up this dissertation seek to elucidate factors influencing perinatal health in the US. The knowledge gained through these studies is intended to provide evidence to assist the health system and clinicians in supporting pregnant and postpartum patients. At the forefront of these studies is attention to social determinants of health for birthing persons and infants. This dissertation is composed of three manuscripts focusing on 1) maternal discrimination experiences (manuscript one), 2) an innovative prenatal care model (Manuscript two), and 3) topics discussed online among pregnancy communities (manuscript three). The following sections provide an overview of the rationale and design of each of these studies, followed by study aims and layout of subsequent chapters.

Manuscript 1: The Impact of Discrimination on Perinatal health

Race is increasingly recognized as a proxy for life experiences of structural and interpersonal racism. Studies of genetic variation provide little evidence of innate biological differences as the basis of racial and ethnic disparities in perinatal health.^{12,13} A life course perspective of maternal and child health suggests birth outcomes are influenced by socially patterned exposures to risk and protective factors not just in the nine months of pregnancy, but cumulatively and at sensitive life stages across the life span.¹⁴ A large and growing body of research documents the negative effect of discrimination on health.^{15,16} Heightened lifetime exposure to the stressor of persistent discrimination experienced by Black birthing persons may

result in worsened birth outcomes.¹⁷ A review of studies examining the impact of maternal discrimination on perinatal health, suggests maternal experiences of interpersonal discrimination at least partially account for racial disparities in birth outcomes.^{18,19} This research has largely been limited by a focus on a single form of discrimination, most commonly racial discrimination.^{23,16} The tendency to measure racism exclusively as the single factor contributing to poor perinatal health outcomes may neglect nuances in the discrimination experience of Black birthing persons and potentially underestimates the overall impact of discrimination on perinatal health.²⁰

There is a need for research addressing individuals' simultaneous occupancy of multiple social categories of oppression or privilege.²¹ An intersectional perspective recognizes inequalities cannot be fully understood in isolation but rather are the outcome of multiple intersecting social identities and systems of oppression.^{22,23} Previous application of an intersectional perspective that considers the meaning and consequences of multiple social categories simultaneously has been challenging in quantitative analysis, but recent advances in statistical methods offer novel opportunities.²⁴

The first manuscript of this dissertation applies an innovative quantitative approach to the examination of maternal discrimination experiences. Data from a large, randomized controlled trial (RCT) of low-income patients receiving prenatal care at a community clinic were analyzed.²⁵ Using the person-centered method of latent class analysis, patients were classified by multifaceted reports of discrimination, thereby better capturing birthing persons intersectional experience of discrimination. Discrimination profiles were formed based on participants report of the frequency of discrimination experienced in their day-to-day life, experience of discrimination in prenatal care and the identify characteristics in which the discrimination was attributed

including gender, race, skin color or ethnicity, sexual orientation, age, ancestry, national origin or immigration status, language, religion, weight or some other aspects of physical appearance, insurance or Medicaid status, education, income level and being pregnant.^{26,27} The association of latent class designations with adverse neonatal and maternal birth outcomes were then explored using multivariate regression.

Manuscript 2: A Promising Alternative Model of Prenatal Care

A life course approach suggests a reduction in black-white birth outcome disparities requires the promotion of quality health care across the lifespan, enhancement of family and community systems and for underlying structural inequities to be addressed.²⁸ Enhancing the quality of prenatal care is one component of the life course strategy to reduce racial disparities in perinatal health. Prenatal care is vitally important in both the continuum of maternal health care and as the beginning of a child's developmental trajectory.²⁸ One promising strategy to enhance the quality of prenatal care is the alternative care model of group prenatal care (GPNC).²⁹

GPNC is an innovative model of prenatal care, that integrates clinical assessment with extensive health education and socialization within a group of patients with similar due dates. GPNC is one of the few clinical interventions to show potential for reducing black-white birth outcome disparities.³⁰ While promising, evidence of GPNC's benefit over and above individual prenatal care (IPNC) is mixed.^{31,32} Despite early randomized control trials (RCTs) and observational studies including large, matched cohort study findings that GPNC is associated with a reduced risk in adverse birth outcomes, recent metaanalyses of GPNC RCTs find the effect of GPNC is similar to and no worse than IPNC.^{33,34} Selection bias in observational studies in which participants are not randomized to care, may account for this discrepancy, suggesting that

it is something about the patients who choose to participate in GPNC that leads to enhanced effects, such as an enhanced motivation for change.^{35,36}

The theoretical framework of how GPNC may lead to improved perinatal health is not yet clear, though studies suggest GPNC offers enhanced education, patient-provider communication and social support, as well as reductions in stress.³⁷ It's hypothesized that GPNC is a good option for some but not all patients and that GPNC may offer the greatest benefit for those that are most vulnerable.^{37,38} Some studies have found Black pregnant persons and those with high psychosocial risk demonstrate more benefit from participation in group prenatal care.^{39,40} Despite these hypotheses, there is limited evidence as to what patients select and attend GPNC, with available studies producing inconsistent findings.^{41,42,43,44,45,46,47} Previous studies have been limited by a focus on hypothetical interest in participation prior to GPNC implementation within the practice or a blunt measure of GPNC attendance. Additionally, studies have been primarily quantitative in nature and have not involved an in-depth analysis of patient perceptions.

To address this gap, the second manuscript in this dissertation utilized a concurrent mixed methods study design to investigate what patients participate in GPNC and why? Data from the Centering and Racial Disparities (CRADLE) study a large RCT comparing GPNC to IPNC among an underserved clinic population was analyzed.²⁵ The CRADLE study offers a large and racially diverse sample of patients, randomly assigned to attend GPNC in a practice with an established GPNC program. Multivariate logistic regression models were used to determine sociodemographic, psychosocial and health characteristics associated with attendance in GPNC as assigned. GPNC attendance was captured as the percentage of eligible GPNC sessions attended across three timeframes during pregnancy. A coinciding analysis of semi-structured patient Interviews took place. Serial interviews conducted among a convenience sample of trial

patients assigned to GPNC and IPNC were qualitatively analyzed using applied thematic analysis, exploring patient perceptions of match between patient and prenatal care model factors.

Manuscript 3: Health Information Online

In addition to participating in offline pregnancy groups such as in GPNC, pregnant persons access online discussion forums where pregnancy-related topics are discussed. In the past decades the internet has increasingly emerged as a source of health information during pregnancy.⁴⁸ When searching for pregnancy information on the internet users frequently come into contact with online discussion forms.⁴⁹ Online forums related to pregnancy allow users to communicate remotely with peers, posting comments, providing responses and viewing the conversations of others at any time of day. During pregnancy, patients report using the internet to fulfill unmet information and support needs, commonly supplementing care provided by health care professionals.^{50,51,52} While online pregnancy forums are commonly utilized as a source of information and support during pregnancy, there is concern over the accuracy of information shared in peer channels.⁵³ Understanding what information pregnant patients seek online is important, as information found online has real world implications on patients pregnancy related decision making.⁵¹

The archival nature and constant content generated in online pregnancy forums, provides a vast and diverse range of user generated content for analysis, without need for intrusive or intensive data collection procedures. These methods may capture populations who would not otherwise participate in research.⁵⁴ Previous analysis of online pregnancy forums have varied greatly in their aim and samples of interest but as a whole have primarily employed qualitative methods of analysis. While capturing contextual complexity, the intensive nature of qualitative analysis often precludes examination of large datasets, such as are available in online forums.⁵⁵

Natural language processing leverages machine learning to analyze large amounts of text data quickly.⁵⁶ Frameworks combining natural language processing techniques with qualitative analysis allow researchers to embrace the volume and diversity of online content.⁵⁷

The third manuscript of this dissertation utilizes the natural language processing technique of topic modeling to explore discussions in online pregnancy forums. User generated content was extracted over a one-year period from three popular online pregnancy forums (thebump.com, Whattoexpect.com and babycenter.com). Latent Dirichlet Allocation (LDA) topic modeling was used to organize content into topics based on word co-occurrence, uncovering prevalent themes of discussion.⁵⁸ Further, the summary of prevalent themes in online pregnancy forums were categorized based on whether they related to health.

Dissertation Aims

The specific aims of this dissertation are as follows:

Manuscript 1.

Specific Aim 1a. Utilizing an intersectional approach, examine whether pregnant patients can be classified based on multifaceted discrimination experiences through latent class analysis.

Specific Aim 1b. Explore the association of latent discrimination classifications with risk of adverse maternal and neonatal birth outcomes through multivariate logistic regression.

Manuscript 2.

Specific Aim 2a. Investigate whether GPNC attendance differs by patient sociodemographic, psychosocial and health characteristics through quantitative analysis of patient surveys and EMR data.

Specific Aim 2b. Compare patient perceptions of care and the match between prenatal care services received and patient needs among patients receiving IPNC and GPNC through qualitative analysis of patient interviews.

Manuscript 3.

Specific Aim 3a. Explore prevalent topics of discussion in three popular online pregnancy forums through topic modeling.

Dissertation Organization

This dissertation is organized into seven chapters. Following this introduction there is an extensive review of literature (chapter 2) and a description of the methods utilized in each study (chapter 3). The three distinct studies composing this dissertation are presented in chapters 4-6. Chapter 4 describes the quantitative analysis of pregnant persons discrimination experiences and the association with adverse birth outcomes. Chapter 5 reports the mixed methods study of characteristics associated with participation in GPNC and factors contributing to a patient-care match. Chapter 6 presents the text mining analysis of user generated content on popular online pregnancy forums. Following the presentation of each study individually, the three studies are discussed together, and contributions, limitations and further research directions considered (Chapter 7). Accompanying tables and figures are presented at the end of each chapter and supplementary materials included in the appendices.

References

1. *Reproductive health indicators: guidelines for their generation, interpretation and analysis for global monitoring.* (World Health Organization, 2006).
2. Ely, D. M. & Driscoll, A. K. Infant Mortality in the United States, 2018: Data From the Period Linked Birth/Infant Death File. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **69**, 1–18 (2020).
3. Centers for Disease Control and Prevention National Center for Health Statistics National Vital Statistics System. Mortality in the United States, 2020. www.cdc.gov
<https://www.cdc.gov/nchs/products/databriefs/db427.htm>.
4. Organization for Economic Cooperation and Development. CO1.1. Infant mortality. www.oecd.org https://www.oecd.org/els/family/CO_1_1_Infant_mortality.pdf.
5. Centers for Disease Control and Prevention. Pregnancy Mortality Surveillance System. www.cdc.gov <https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm>.
6. Douthard, R. A., Martin, I. K., Chapple-McGruder, T., Langer, A. & Chang, S. U.S. Maternal Mortality Within a Global Context: Historical Trends, Current State, and Future Directions. *J. Womens Health* **30**, 168–177 (2021).
7. Hoyert, D. *Maternal Mortality Rates in the United States, 2020.*
<https://stacks.cdc.gov/view/cdc/113967> (2022) doi:10.15620/cdc:113967.
8. The Commonwealth Fund. What is the Status of Women’s Health and Health Care in the US Compared to Ten Other Countries? www.commonwealthfund.org
<https://www.commonwealthfund.org/publications/issue-briefs/2018/dec/womens-health-us-compared-ten-other-countries>.
9. Singh, G. K. & Yu, S. M. Infant Mortality in the United States, 1915-2017: Large Social Inequalities have Persisted for Over a Century. *Int. J. Matern. Child Health AIDS IJMA* **8**, 19–31 (2019).
10. Petersen, E. E. *et al.* Racial/Ethnic Disparities in Pregnancy-Related Deaths — United States, 2007–2016. *MMWR Morb. Mortal. Wkly. Rep.* **68**, 762–765 (2019).
11. Ely, D. M. & Driscoll, A. K. Infant Mortality in the United States, 2019:Data From the Period Linked Birth/Infant Death File. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **70**, 1–18 (2021).
12. Williams, D. R., Lavizzo-Mourey, R. & Warren, R. C. The concept of race and health status in America. *Public Health Rep. Wash. DC 1974* **109**, 26–41 (1994).

13. Zambrana, R. E. & Williams, D. R. The Intellectual Roots Of Current Knowledge On Racism And Health: Relevance To Policy And The National Equity Discourse. *Health Aff. Proj. Hope* **41**, 163–170 (2022).
14. Lu, M. C. Childbirth Education Classes: Sociodemographic Disparities in Attendance and the Association of Attendance with Breastfeeding Initiation. *Matern. Child Health J.* **7**, 87–93 (2003).
15. Williams, D. R., Lawrence, J. A., Davis, B. A. & Vu, C. Understanding how discrimination can affect health. *Health Serv. Res.* **54**, 1374–1388 (2019).
16. Lewis, T. T., Cogburn, C. D. & Williams, D. R. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. *Annu. Rev. Clin. Psychol.* **11**, 407–440 (2015).
17. Leimert, K. B. & Olson, D. M. Racial disparities in pregnancy outcomes: genetics, epigenetics, and allostatic load. *Curr. Opin. Physiol.* **13**, 155–165 (2020).
18. Larrabee Sonderlund, A., Schoenthaler, A. & Thilsing, T. The Association between Maternal Experiences of Interpersonal Discrimination and Adverse Birth Outcomes: A Systematic Review of the Evidence. *Int. J. Environ. Res. Public Health* **18**, 1465 (2021).
19. Alhusen, J. L., Bower, K. M., Epstein, E. & Sharps, P. Racial Discrimination and Adverse Birth Outcomes: An Integrative Review. *J. Midwifery Womens Health* **61**, 707–720 (2016).
20. Lewis, T. T. & Van Dyke, M. E. Discrimination and the Health of African Americans: The Potential Importance of Intersectionalities. *Curr. Dir. Psychol. Sci.* **27**, 176–182 (2018).
21. Williams, D. R. & Mohammed, S. A. Racism and Health I: Pathways and Scientific Evidence. *Am. Behav. Sci.* **57**, 1152–1173 (2013).
22. Crenshaw, K. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory, and Antiracist Politics. in *Living with Contradictions* (ed. Jaggar, A. M.) 39–52 (Routledge, 2018). doi:10.4324/9780429499142-5.
23. Hankivsky, O. *Intersectionality 101*. (The Institute for Intersectionality Research & Policy, SFU, 2014).
24. Else-Quest, N. M. & Hyde, J. S. Intersectionality in Quantitative Psychological Research: II. Methods and Techniques. *Psychol. Women Q.* **40**, 319–336 (2016).
25. Chen, L. *et al.* Centering and Racial Disparities (CRADLE study): rationale and design of a randomized controlled trial of centeringpregnancy and birth outcomes. *BMC Pregnancy Childbirth* **17**, 118 (2017).

26. Williams, D. R., Yan Yu, Jackson, J. S. & Anderson, N. B. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *J. Health Psychol.* **2**, 335–351 (1997).
27. Centers for Disease Control and Prevention. PRAMS Questionnaires. <http://www.cdc.gov/prams/Questionnaire.htm> (2014).
28. Lu, M. C. *et al.* Closing the Black-White gap in birth outcomes: a life-course approach. *Ethn. Dis.* **20**, S2-62–76 (2010).
29. Schindler Rising, S., Kennedy, H. P. & Klima, C. S. Redesigning prenatal care through CenteringPregnancy. *J. Midwifery Womens Health* **49**, 398–404 (2004).
30. Straub, H., Qadir, S., Miller, G. & Borders, A. Stress and Stress Reduction. *Clin. Obstet. Gynecol.* **57**, 579–606 (2014).
31. Carter, E. B. *et al.* Group Prenatal Care Compared With Traditional Prenatal Care: A Systematic Review and Meta-analysis. *Obstet. Gynecol.* **128**, 551–561 (2016).
32. Tucker, C. M., Felder, T. M., Dail, R. B., Lyndon, A. & Allen, K.-C. Group Prenatal Care and Maternal Outcomes: A Scoping Review. *MCN Am. J. Matern. Nurs.* **46**, 314–322 (2021).
33. Catling, C. J. *et al.* Group versus conventional antenatal care for women. *Cochrane Database Syst. Rev.* **2017**, (2015).
34. Liese, K. L. *et al.* Impact of group prenatal care on key prenatal services and educational topics in Malawi and Tanzania. *Int. J. Gynecol. Obstet.* **153**, 154–159 (2021).
35. Cunningham, S. D. *et al.* Group Prenatal Care Reduces Risk of Preterm Birth and Low Birth Weight: A Matched Cohort Study. *J. Womens Health* **28**, 17–22 (2019).
36. Liu, Y., Wang, Y., Wu, Y., Chen, X. & Bai, J. Effectiveness of the CenteringPregnancy program on maternal and birth outcomes: A systematic review and meta-analysis. *Int. J. Nurs. Stud.* **120**, 103981 (2021).
37. Sheeder, J., Weber Yorga, K. & Kabir-Greher, K. A Review of Prenatal Group Care Literature: The Need for a Structured Theoretical Framework and Systematic Evaluation. *Matern. Child Health J.* **16**, 177–187 (2012).
38. Byerley, B. M. & Haas, D. M. A systematic overview of the literature regarding group prenatal care for high-risk pregnant women. *BMC Pregnancy Childbirth* **17**, 329 (2017).
39. Ickovics, J. R. *et al.* Group Prenatal Care and Perinatal Outcomes: A Randomized Controlled Trial. *Obstet. Gynecol.* **110**, 330–339 (2007).

40. Heberlein, E. C. *et al.* The comparative effects of group prenatal care on psychosocial outcomes. *Arch. Womens Ment. Health* **19**, 259–269 (2016).
41. Phillippi, J. C. & Myers, C. R. Reasons Women in Appalachia Decline CenteringPregnancy Care. *J. Midwifery Womens Health* **58**, 516–522 (2013).
42. Weber Yorga, K. D. & Sheeder, J. L. Which Pregnant Adolescents Would be Interested in Group-Based Care, and Why? *J. Pediatr. Adolesc. Gynecol.* **28**, 508–515 (2015).
43. McDonald, S. D. *et al.* Why Are Half of Women Interested in Participating in Group Prenatal Care? *Matern. Child Health J.* **20**, 97–105 (2016).
44. Cunningham, S. D., Lewis, J. B., Thomas, J. L., Grilo, S. A. & Ickovics, J. R. Expect With Me: development and evaluation design for an innovative model of group prenatal care to improve perinatal outcomes. *BMC Pregnancy Childbirth* **17**, 147 (2017).
45. Berman, R., Weber Yorga, K. & Sheeder, J. Intention to Participate in Group Prenatal Care: Moving Beyond Yes or No. *Health Promot. Pract.* **21**, 123–132 (2020).
46. Francis, E. *et al.* Group Prenatal Care Attendance and Women’s Characteristics Associated with Low Attendance: Results from Centering and Racial Disparities (CRADLE Study). *Matern. Child Health J.* **23**, 1371–1381 (2019).
47. Wagijo, M. R. *et al.* CenteringPregnancy in the Netherlands: Who engages, who doesn’t, and why. *Birth* **49**, 329–340 (2022).
48. Sayakhot, P. & Carolan-Olah, M. Internet use by pregnant women seeking pregnancy-related information: a systematic review. *BMC Pregnancy Childbirth* **16**, 65 (2016).
49. Farrant, K. & Heazell, A. E. P. Online information for women and their families regarding reduced fetal movements is of variable quality, readability and accountability. *Midwifery* **34**, 72–78 (2016).
50. Lagan, B. M., Sinclair, M. & George Kernohan, W. Internet Use in Pregnancy Informs Women’s Decision Making: A Web-Based Survey. *Birth* **37**, 106–115 (2010).
51. Lagan, B. M., Sinclair, M. & Kernohan, W. G. What Is the Impact of the Internet on Decision-Making in Pregnancy? A Global Study. *Birth* **38**, 336–345 (2011).
52. Bert, F. *et al.* Pregnancy e-health: a multicenter Italian cross-sectional study on internet use and decision-making among pregnant women. *J. Epidemiol. Community Health* **67**, 1013–1018 (2013).
53. Ellis, L. & Roberts, L. Exploring the use and quality of Internet discussion forums in pregnancy: A qualitative analysis. *Birth* **47**, 153–161 (2020).

54. Holtz, P., Kronberger, N. & Wagner, W. Analyzing Internet Forums: A Practical Guide. *J. Media Psychol.* **24**, 55–66 (2012).
55. Baumer, E. P. S., Mimno, D., Guha, S., Quan, E. & Gay, G. K. Comparing grounded theory and topic modeling: Extreme divergence or unlikely convergence? *J. Assoc. Inf. Sci. Technol.* **68**, 1397–1410 (2017).
56. Chang, T. *et al.* Accelerating Mixed Methods Research With Natural Language Processing of Big Text Data. *J. Mix. Methods Res.* **15**, 398–412 (2021).
57. Andreotta, M. *et al.* Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behav. Res. Methods* **51**, 1766–1781 (2019).
58. Blei, D. M., Ng, A. Y. & Jordan, M. I. Latent Dirichlet Allocation. *J. Mach. Learn. Res.* **3**, 993–1022 (2003).

CHAPTER TWO

LITERATURE REVIEW

Chapter Overview

This chapter will provide a comprehensive overview of previous research pertinent to the three individual research manuscripts included within this dissertation. First, information on the state of perinatal health in the United States will be reviewed. Then explanations for the stark racial disparities in perinatal health outcomes will be discussed, with a focus on the link between exposure to discrimination and worsened health. Findings of previous studies examining the association between discrimination and adverse birth outcomes will then be summarized and gaps in the literature alluded to (Manuscript One). Next, details on an alternative model of prenatal care: group prenatal care (GPNC) will be given. Findings of randomized controlled trial and observational studies of GPNC effectiveness will then be reviewed and rationale for examining patient characteristics associated with GPNC attendance given (Manuscript Two). Finally, use of the internet for health information in pregnancy will be considered including the utility of analyzing online content generated by pregnant persons. Previous research examining user generated content in online pregnancy forums will be summarized and a innovative technique for analysis discussed (Manuscript 2). The chapter will close with a brief overview of manuscript objectives.

The State of Perinatal Health

Infant Mortality and Morbidity in the United States

Infant mortality rate (IMR) is defined as the number of children who die prior to their first birthday per every 1,000 live births.¹ IMR is considered a key marker of national health, as it reflects several important health indicators including maternal health, access to health care and

public health practices.² IMR in the United States (US) has declined considerably over the past several decades, decreasing from a recent high of 6.9 in 2005 to 5.4 deaths per 1,000 live births in 2020.³⁴ The leading causes of death in children under the age of one in the US are congenital malformations, preterm birth and low birth weight, sudden infant death syndrome (SIDS), unintentional injuries, and maternal pregnancy complications.¹

Infant Mortality Rate in Peer Countries

Despite marked improvement, IMR in the US lags far behind other industrialized countries. The US ranks 34th out of the 44 Organization for Economic Cooperation and Development (OECD) countries, which on average have an IMR of 4.1 deaths per 1,000 live births.⁵ The US's unfavorable ranking is made more striking considering health care spending in the US is twice that of any other nation.⁶ The US's poor ranking is attributed to elevated rates of preterm birth (infants born at <37 week gestational age) and associated delivery of low birth weight infants (<2,500 g) compared with European nations.² While mortality rates in very preterm infants (24-31 weeks gestational age) are comparable to most European countries, the comparison becomes more disparate as gestational age increases. Among infants delivered between 32 and 36 weeks, mortality rates in the US are higher than all comparison European countries.⁷

Infant Mortality by Race and Ethnicity

IMR in the US is improving at a slower rate than peer nations and not all races or ethnicities have benefited equally from improvements. Between 2005 and 2014, IMR declined 21% for infants of Asian or Pacific Islander (from 4.9 to 3.9), 20% for infants of non-Hispanic Black (from 13.6 to 10.9), 15% for infants of non-Hispanic White (from 5.8 to 4.9) and 11% for infants of Hispanic mothers (from 5.6 to 5.0).³ Racial and ethnic disparities in IMR have

persisted and even increased over time, such that the relative gap in IMR across racial and ethnic groups is wider today than it was in the 1950s.⁸ In the US, Infants of Non-Hispanic Black mothers have the highest IMR of any race or ethnicity. Infants of Black mothers die at almost twice the rate of infants of non-Hispanic White mothers.⁹ Mortality rates are higher for all leading causes of death in the first year of life. Over half the Black-White disparity in IMR is attributed to differential rates of preterm birth. Infants of non-Hispanic Black mothers are three times more likely to experience prematurity related infant mortality than infants of non-Hispanic White mothers. Wide racial and ethnic disparities in IMRs, particularly between infants of non-Hispanic Black and non-Hispanic White mothers, suggest not all groups have benefited equally from social and medical advances.²

Consequences of Preterm Birth

Preterm birth is associated with lasting health consequences that perpetuate racial disparities in health and socioeconomic status across the life span. Infants born prematurely have an increased risk of developing long term respiratory, cardiovascular, gastrointestinal, neurodevelopmental and emotional conditions.¹⁰ They experience higher rates of cerebral palsy, visual and auditory deficits, intellectual impairment and developmental lags.¹¹ Premature infants are more likely to develop attention deficit disorder, anxiety and depression.^{12,13} Increased risk of disability persists into adulthood, with adults born preterm having higher insulin resistance, glucose intolerance and blood pressure than those born at term.^{14,15} Preterm birth is also associated with worsened functional achievement including lower educational attainment, greater unemployment and lower income levels compared to full term peers.^{16,17}

Cost of Neonatal Morbidity

Health consequences associated with preterm birth and other neonatal morbidities result in substantial costs to the health sector, as well as burdens on education and social services.¹⁸ The Institute of Medicine estimates an excess of \$26 billion or \$51,600 per infant is associated with preterm birth annually in the US.¹⁹ To date this estimate is the most comprehensive measure of the cost of preterm birth in the US. It includes maternal delivery costs, medical care and early intervention costs up to age five and disability specific lifetime medical costs for select disabilities associated with preterm birth, yet it still likely underestimates the true cost of preterm birth on society.²⁰

Maternal Mortality and Morbidity in the United States

Maternal mortality and morbidity metrics provide the companion piece in the narrative of birth outcomes in the US. Pregnancy-related deaths (PRDs) are the death of a birthing person while pregnant or within one year of the end of pregnancy per 100,000 live births.²¹ Nearly 31% of PRDs occur prior to delivery, 56% occur during labor or within the first six weeks postpartum and another 13% occur between six weeks and one year postpartum.²² Cardiovascular conditions, other non-cardiovascular medical conditions and infection are the leading causes of PRDs in the US.²³

For every individual who dies as a result of pregnancy, a hundred more experience life-threatening health complications related to pregnancy.²⁴ Severe maternal morbidity (SMM) is defined as life-threatening complications of labor and delivery that result in short- and long-term health consequences calculated per 10,000 deliveries.²⁵ SMM are identified using administrative hospital discharge data and international classification of disease (ICD) codes, with 21 codes classified as indicating SMM. Leading indicators of SMM include blood transfusion,

hysterectomy, disseminated intravascular coagulation, adult respiratory distress syndrome and acute renal failure.²⁶

While IMR has slowly but steadily improved in the US over the past decades, rates of maternal mortality have not seen a similar decline. Since the pregnancy mortality surveillance system (PMSS)'s inception in 1987 the rate of PRDs has risen from 7.2 deaths per 100,000 live births to 23.8 deaths as of 2020.^{27,28} Approximately 700 birthing persons in the US die each year due to pregnancy or delivery related complications, more than half of these deaths are through to be preventable.²¹

Rates of SMM have risen over the same period, increasing from 60 to 160 birthing persons with SMM per 10,000 delivery hospitalizations.²⁹ More than 50,000 birthing persons in the US are affected by SMM each year. These figures include only obstetric complication occurring during labor and birth, and do not illustrate the many other health problems that are common during pregnancy and postpartum.²⁵

Maternal Morbidity and Mortality in Peer Countries

As is the case with IMR, the US remains an outlier among similar nations in its high rates of maternal mortality and morbidity. Globally rates of maternal mortality have declined, dropping 35% from the estimated 451,000 maternal deaths in 2000 to 295,000 maternal deaths in 2017. The global maternal mortality rate has on average declined 2.9% every year between 2000 and 2017. The greatest reduction has been observed in low-income countries where the maternal mortality rate was extremely high, whereas in regions where the MMR was already relatively low less reduction was observed. In Europe, the maternal mortality rate declined by more than 53% between 2000 and 2017. The reverse was observed in the US, maternal mortality rate increased by 52% over the same period.³⁰ The US is the only developed nation that has

experienced an increase in maternal mortality rates in recent years. Rates of maternal mortality in the US is more than double that of other high-income countries. For example the maternal mortality rate in Australia was 4.8 deaths, the United Kingdom was 6.5 deaths and Canada is 8.6 deaths in 2017 compared to 17.4 deaths per 100,000 live births in the US.³¹

Reasons for Rising Maternal Mortality and Morbidity

Reasons for the rising maternal mortality and morbidity in the US are likely multifactorial. Rising rates likely reflect improvements in PRD and SSM identification due to the creation of dedicated monitoring systems and computerized data linkage.²⁷ Increases in certain pregnancy complications and risk factors, including rates of multiple births, cesarian delivery, delivery at a gestational age less than 34 weeks, obesity and older age also likely contribute to rising rates, as well as increased prevalence of pre-existing chronic diseases among pregnant persons.^{29,32,33,34} In addition to shifts in delivery practices and population health, legislative changes including state level adoption of abortion restrictions may contribute to increased rates of maternal mortality.^{35,36} Alongside rising rates of maternal mortality and morbidity in the US, there has been widening gaps between subgroups.

Maternal Morbidity and Mortality by Race and Ethnicity

As is the case infant mortality, significant racial and ethnic disparities in maternal mortality and morbidity exist in the US.^{37,23} Non-Hispanic Black birthing persons are more than three times as likely to die a PRD and are more than twice as likely to experience SMM than non-Hispanic White.²² While delivery complications occur at similar rates among non-Hispanic Black and non-Hispanic White patients, non-Hispanic Black birthing persons experience 2 to 3 times higher case-fatality for the same complications.³⁸ Racial disparities in the prevalence of preexisting chronic disease have also widened over time.³⁹ Disparate rates of chronic diseases

likely contribute to the stark racial and ethnic disparity in pregnancy-related morbidity and mortality, disproportionately burdening non-Hispanic Black birthing persons.⁴⁰

Cost of Maternal Morbidity

Maternal mortality and morbidity carry substantial health care costs. The average cost of delivery with SMM is nearly double that of delivery without SMM.⁴¹ Over a five-year period, deliveries with SMM were estimated to cost an excess of \$83 million in New York City hospitals. While striking, this figure likely far underestimates the health care costs of SMM as costs accrued outside of the delivery hospitalization are not included. Birthing persons with SMM are more than twice as likely to experience hospital readmissions compared to those without SMM.⁴² Accounting for physician and SMM related readmission costs increases cost estimates of SMM by more than 70%.⁴³

Explanations for Black-White Disparities

Understanding the mechanisms promoting and maintaining racial disparities in adverse birth outcomes is vital to the implementation of evidence-based strategies for change. Historic explanations focusing on genetics, socioeconomic status, health behaviors and access to care have failed to sufficiently account for the magnitude of racial disparities in birth outcomes.^{44,45}

Genetics. As genetic sciences have improved, race has come to be understood largely as a social construct.⁴⁶ Biometric genetic models suggest genetics are not a leading contributor to racial disparities in adverse birth outcomes, rather the association between race and birth outcomes is likely due to environmental factors.⁴⁷ The role of the environment is highlighted in studies comparing birth outcomes among US and foreign-born Black pregnant persons.^{48,49} Foreign-born Black pregnant persons are found to have more favorable birth outcomes than Black pregnant persons born in the US, despite foreign born pregnant persons typically being of

lower socioeconomic status. The protective benefits of being foreign born dissipate in future generations.⁵⁰ These findings implicate the role of growing up Black in the US rather than innate biological differences in producing the Black-White gap in birth outcomes.

Income and Education. As in the case of genetics, greater poverty among Black families does not sufficiently account for Black-White disparity in birth outcomes. While non-Hispanic White pregnant persons experience protective benefits against adverse birth outcomes with increased socioeconomic status, non-Hispanic Black pregnant persons experience no such benefits.⁵¹ Racial disparities persist across education and income levels.⁵² In fact, the largest Black-White racial disparities are observed among upper middle-class pregnant persons. Non-Hispanic Black birthing persons with graduate degrees have higher rates of SMM than non-Hispanic White birthing persons who never graduated high school.^{53,41} Socioeconomic status is estimated to account for only about 20% of the racial difference in preterm birth and low birth weight.⁵⁴

Health Behavior and Health Care Access. Difference in health behavior and health care access by race also fail to fully account for racial disparities in birth outcomes. Many of the risk factors for adverse birth outcomes (e.g. education, cigarette smoking, substance use, housing, mental health) are found to be more common among low income White pregnant persons than Black, yet still adverse birth outcomes are substantially more common among Black pregnant persons.⁵⁵ Among members of the military a group within the US where access to health care is equal across races, racial disparities in birth outcomes are attenuated but not eliminated. When receiving equal access to health care non-Hispanic Black military members still have an increased risk for preterm birth and low birth weight compared to their non-Hispanic White peers.⁵⁶ The failure of genetics, socioeconomic status, health behaviors and

health care access to sufficiently account for existing racial disparities in birth outcomes, has led many to adopt a wider view of the issue.

A life Course Perspective. A life course perspective considers life not as disconnected stages but as an integrated continuum, recognizing the influence of prior stages on those that follow. It provides a longitudinal account of the interactions between biological, behavioral, psychological, social, and environmental factors across the life span in the production of health.⁵⁷ The life course perspective integrates longitudinal models of early programming and cumulative pathways.⁵⁸ Through a life course approach, birth outcomes are conceptualized as the product of not only the nine months of pregnancy, but also the mother's life leading up to conception. Factors such as socioeconomic status, housing, education, social support, and discrimination are framed as risk or protective exposures. Racial disparities in birth outcomes are attributed to differential exposures during pregnancy, as well as in prior life stages.⁵⁹ A life course perspective is consistent with theories of allostatic load and “weathering”.

Allostatic Load. Allostatic load describes the wear and tear on the body that occurs in response to external stressors and produces ill health.⁶⁰ Allostasis is the adaptive process of maintaining homeostasis in the body in response to environmental stressors. Stress responses involve activation of the hypothalamic pituitary adrenal (HPA) axis, elevated blood pressure and glucose production, as well as altered immune system activity in preparation of going into “fight or flight” mode. Repeated and sustained activation of stress responses disrupt immune system balance leading to inflammation and a reduced ability to manage future exposure to stressors.⁴⁴ Elevated allostatic load is associated with risk of adverse birth outcomes including preterm birth, low birth weight, and preeclampsia.^{61,62,63} Non-Hispanic Black persons have been found to have the highest allostatic load scores of all demographic groups.⁶⁴ When applied to birth outcomes,

the theory of allostatic load suggests stress from repeated experiences of structural inequalities and interpersonal discrimination contribute to metabolic conditions that exacerbate non-Hispanic Black birthing persons' risk of adverse birth outcomes. This theory is aligned with the concept of "weathering".

Weathering. The theory of "weathering" is aligned with the concept of allostatic load, and posits that the cumulative impact of heightened stressors within marginalized communities result in accelerated aging and earlier onset of adverse health conditions, through complex mechanisms.⁶⁵ Advanced biological weathering among Black persons compared to their White counterparts of the same age provides an explanation for racial disparities in birth outcomes.⁴⁷ Black persons' allostatic load scores are higher than White at all ages and widen with additional years of age.⁶⁶ When telomere length (a biomarker of cellular aging) is measured, Black persons are biologically seven and a half years older than White of the same chronological age, with racial differences in health deterioration evident across socioeconomic status.⁶⁷ Theories of allostatic load and weathering provide plausible biological mechanisms for the paradoxical findings that wealth and educational attainment do not buffer persons of color against risk of adverse maternal and infant outcomes.⁶³

Discrimination and Perinatal Health (Manuscript One)

Discrimination as a Stressor

Discrimination has been defined as "a socially structured and sanctioned phenomenon, justified by ideology and expressed in interactions among and between individuals and institutions, that maintains privileges for members of dominant groups at the cost of deprivation for others."⁶⁸ Discrimination is enacted at multiple levels.⁶⁹ Individual or interpersonal discrimination occurs in encounters between individuals in which the disadvantaged individual is

acted upon differentially based on their identity. Interpersonal discrimination can be action or inaction that is intentional or unintentional. Interpersonal discrimination manifests in a plethora of ways including “lack of respect, suspicion, devaluation scapegoating and dehumanization”.⁷⁰ Discrimination is also enacted at structural or systematic level, whereby macro-level conditions limit the opportunities, resources, and well-being of oppressed groups. It is through structural and institutionalized discrimination that oppression becomes normalized and at times legalized or codified within the customs and practices of systems and institutions. Structural discrimination encompasses the manners in which societies reinforce unequal social structures including policy, housing, education, employment, media, health care and criminal justice.⁷¹ Exposure to discrimination is primarily conceptualized as a psychological and physiological stressor, that influences health over time through repeated activation of stress responses. Exposure to discrimination is also thought to affect health through motivating increased engagement in behaviors that while momentarily adaptive are damaging to health long-term.⁷²

Discrimination and Health Disparities

While the current paper focuses on racial disparities in maternal child health, substantial inequity exists in the US for wider health care access, care quality received and a litany of health outcomes for which socially disadvantaged racial populations have poorer health than White.⁷³ A large and growing body of research suggests experiences of discrimination have negative health consequences that may at least partially account for racial disparities in health. Experiences of discrimination have been associated with adverse general health, poor mental health (including anxiety and depression symptoms, psychological distress and risk of psychiatric disorders), poor physical health (including cardiovascular disease, hypertension, diabetes and respiratory conditions), pre-clinical indicators of disease (including cortisol, blood pressure, intramedial

thickness and inflammation), greater risky health behaviors and fewer health-promoting activities (including smoking cigarettes, alcohol consumption, drug use and diminished sleep quality).⁷⁴ Evidence linking discrimination to health is most robust surrounding mental health and health behaviors, while findings demonstrating a relationship between discrimination and physical health outcomes are less consistent.^{71,75} Studies have primarily examined race and ethnicity based discrimination, with less research focused on discrimination based on other identity characteristics (e.g. gender, sexual orientation, age etc.). Research has largely focused measuring discrimination at the individual level rather than systematic or institutional discrimination, though studies of this nature are growing.⁷¹

A Review of Discrimination and Adverse Birth Outcomes

A number of studies have been conducted examining the impact of maternal experience of discrimination on perinatal health outcomes. Literature investigating the relationship between interpersonal maternal discrimination and adverse maternal and neonatal birth outcomes will be reviewed. This review will build upon Larrabee Sondurlund et al.'s systematic review of literature published prior to 2021.⁷⁶ Larrabee Sonderlund et al.'s review follows three prior reviews of literature in this area.^{77,78,79} While previous reviews reported mixed findings, in their updated review Larrabee Sonderlund et al. suggests the literature provides overwhelming support for the conclusion maternal experiences of interpersonal discrimination are associated with increased risk of adverse pregnancy outcomes.

The extent of research investigating the relationship between maternal discrimination and Black-White birth outcome disparities in the US will be reviewed. Relevant articles from Larrabee Sonderlund et al.'s reference list, as well as available research published following December 2020 will be eligible for inclusion A search was executed in the Web of Knowledge

and Medline databases for available articles published from 2021 to present. Search terms utilized included: “Pregnant” OR “Pregnancy” OR “maternal” OR “perinatal” AND “Discrimination” OR “prejudice” OR “stereotype “ OR “stigma” OR “racism” OR “unfair treatment” OR “sexism” OR “ageism” OR “weight prejudice” OR “weight stigma” OR “disability stigma” AND “Birth” OR “Birth outcomes” OR “preterm birth” OR “premature birth” OR “birth weight” OR “low birth weight” OR “small for gestational age” OR “neonatal outcomes” OR “miscarriage” OR “stillbirth” OR “maternal outcomes” OR “pregnancy Complications”. In keeping with Larrabee Sonderlund et al., articles were included for review if they reported on the relationship between maternal experiences of interpersonal discrimination and birth outcomes, were in English, reported quantitative results, had undergone scientific peer review and if full text was available. Additionally, only articles conducted in the US that involve African American or Black pregnant persons were included for review, in keeping with a focus on understanding the persisting Black-White gap in outcomes in the US.

Structural Discrimination and Adverse Birth Outcomes. While this review focused on studies of interpersonal discrimination, structural and institutional discrimination likely contribute over and above that of interpersonal discrimination alone, influencing minority health.⁸⁰ There is a growing body of research investigating the role of structural and institutional discrimination in relation to maternal and neonatal health disparities. Several proxy measures have been developed to capture the multidimensional construct. Racial residential segregation has been the most frequently examined proxy measure of structural discrimination in the study of adverse birth outcomes. A recent review and meta-analysis of forty-two studies of Black-White racial residential segregation in the US, reported that among Black mothers, racial segregation was associated with increased risk of preterm birth and low birth.⁸¹ Structural discrimination

measures including the Index of Concentration of Extremes (a measurement of spatial social polarization), Jim Crow legislation (racially discriminatory state legalization overturned by the 1964 Civil Rights Act), neighborhood redlining (discriminatory mortgage lending), incarceration of Black individuals, neighborhood police contact and neighborhood greenspace have also been found to influence birth outcomes among Black pregnant persons.^{82,83,84,85,86,87}

Study Characteristics and Methodology. Thirty-six articles examining the effects of interpersonal discrimination on maternal and neonatal outcomes were uncovered, an overview of which is displayed in Table 1. A single study was published prior to the 2000s.⁸⁸ The number of articles published in the 2000s increased exponentially, with eleven articles published between 2000 and 2010 and seventeen articles published between 2011 and 2020. Seven articles were published in the years 2021 and 2022, following the Larrabee Sonderlund et al., review. Studies employed various research designs including prospective cohort (n=16), cross-sectional (n=12), case control (n=5), hybrid retrospective prospective cohort (n=2) and retrospective cohort (n=1) designs. Studies primarily utilized convenience samples recruited during prenatal care or delivery hospitalization (n=28). Four studies utilized data from the Center for Disease Control and Prevention (CDC)'s Pregnancy Risk Assessment Monitory System (PRAMS) postnatal survey a population-based survey that employs stratified random sampling.^{89,90,91,92} Random sampling was additionally employed in two other studies.^{93,94} In addition to recruitment of pregnant persons receiving perinatal care, participants were recruited by mail, telephone, crowdsourcing website (Amazon Mechanical Turk) and social media.^{95,94,96} Sample sizes ranged from 29 to 18,785 participants.^{97,91} Study samples primarily consisted of English or Spanish speaking pregnant persons, 15 year old or older, with singleton intrauterine pregnancies. In several cases only African American or Black (n=19) and persons of color (n=2) were included.

Birthing persons with major complications of pregnancy, chronic conditions contributing to a medically high-risk pregnancy, and who smoked or used illicit drugs were frequently excluded from study samples. Select studies concentrated on specific populations including nulliparous, those with a yearly income under \$11,000 or persons employed full-time.^{97,96}

Measurement of Discrimination. Interpersonal discrimination was assessed using a variety of measures. All but one study included assessment of racial discrimination, this study instead measured discrimination attributed to being pregnant or pregnancy discrimination.⁹⁶ Six studies assessed discrimination attributed to race and ethnicity, as well as other social characteristics including gender, socioeconomic status, age, sexual orientation, religion, physical appearance and physical disability.^{98,99,100,101,102,103,104} Several studies employed validated scales in the measurement of discrimination; frequency, pervasiveness, and emotional response. Measures included the Experiences of Discrimination Scale (EOD, n=18), Everyday Discrimination Scale (EDS, n=8), Racism and Life Experiences Scale¹⁰⁵ (RALES, n=3), Racism-Related Experiences Scale (PRE, n=2), Perceived Racism Scale (PRS, n=2), Daily Life Experiences of Racism and Bother scale (DLE-B, n=1) and the Workplace Prejudice/Discrimination Inventory (n=1).^{106,107,108,109} The PRAMS postnatal survey measured discrimination using 1 to 2 questions assessing whether the participant felt emotionally upset as a result of how they were treated based on their race in the year prior to their baby being born. The timeframe in which discrimination was assessed varied between measures and included every day, while pregnant, in the past year, over the lifetime, in childhood, adolescence or adulthood. Some studies sought to distinguish between the direct (firsthand or personal) and indirect (vicarious) experiences of discrimination.^{110,97,111,112}

Study Findings. While a number of studies examined the effect of maternal discrimination on neonatal birth outcomes of gestational age at birth (n=15) and infant birth weight (n=15), fewer studies were conducting on any single maternal birth outcome. Overall, thirty studies addressed the impact of maternal discrimination on neonatal outcomes and fourteen on maternal outcomes. Maternal outcomes examined included maternal mental health (n=8), health behavior during pregnancy (n=2), physical diseases of pregnancy (n=2) and stress indicators (n=4). Characteristics of studies examining the effect of maternal discrimination on gestational age at birth, infant birth weight and maternal birth outcomes are shown in Table 2, Table 3 and Table 4 respectively. Findings with regards to neonatal outcomes of gestational age at birth and weight at birth will be reviewed first followed by maternal outcomes.

Gestational Age at Birth. Studies primarily measured the outcome of gestational age at birth dichotomously as preterm birth (birth at <37 weeks gestation) vs. term birth (birth at \geq 37 weeks gestation). Eleven of the fourteen reviewed studies assessing the impact of maternal discrimination on gestational age at delivery, reported a significant positive relationship between racial discrimination and risk of preterm birth among the entire study sample or in subgroups. Three studies did not find a significant association between maternal experiences of racial discrimination and infant gestational age at birth.^{113,114,115} In racially stratified analyses, racial discrimination was found to be associated with increased risk of preterm birth among non-Hispanic Black birthing persons but not among Non-Hispanic White.^{99,92} The association of maternal racial discrimination with risk of preterm birth was found to differ by maternal depressive symptomology and stress, as well as the life stage in which discrimination occurred and whether the discrimination was directly or vicariously experienced.^{116,117,112}

Three studies assessed the impact of maternal discrimination based on an identity characteristic other than race and ethnicity on the outcome gestational age of delivery. The sole study of maternal discrimination attributed to pregnancy, pregnancy discrimination in the workplace was found to be indirectly associated with lower gestational age at delivery through maternal stress.⁹⁶ In the two studies examining gender discrimination the odds of preterm birth trended upward but were not found to be statistically significant.^{98,99}

Infant Birth Weight, and Size. Infant birth weight and size were measured in four ways across reviewed studies: as low birth weight defined as less than 2500 grams at delivery, very low birth weight defined as less than 1500 grams at delivery, small for gestational age defined as weight, length or head circumference smaller than 90% of infants of the same gestational age and sex and as a continuous variable. Nine of the twelve studies reviewed reported a significant association between maternal experience of racial discrimination and infant weight or size at delivery in the entire sample or a subgroup. Three studies did not find a significant association between maternal experiences of racial discrimination and infant birth weight.^{88,94,115} Racially and age stratified analysis suggested this relationship was stronger among certain groups, with racial discrimination shown to be significantly associated with infant birth weight among African American persons and those 25 years old and older.^{110,111} Risk factors (i.e. inadequate prenatal care, poor social support, smoking and substance use) were also found to have an impact on the relationship between discrimination and birth weight.¹¹⁸

Three studies assessed the effect of discrimination based on general discrimination, multiple identity characteristics or characteristics other than race and ethnicity on the outcome of infant birth weight. In a study of discrimination based on multiple social identities, despite racial discrimination being the most commonly cited form of discrimination, discrimination based on

age and physical disability were found to be associated with reduced infant birth weight but not racial discrimination.¹⁰⁰ General discrimination was found to be associated with risk of low birth weight and this relationship mediated by maternal depressive symptoms.¹⁰² As was the case with preterm birth, the single study of pregnancy discrimination in the workplace, found pregnancy discrimination was indirectly associated with reduced birth weight through maternal stress.⁹⁶

Maternal Mental Health. The largest concentration of studies investigating the impact of interpersonal discrimination on maternal health focused on mental health outcomes in particular symptoms of depression and psychological distress. Four of the six studies examining maternal mental health found experiences of racial discrimination were positively associated with psychological distress and symptoms of depression. This association was seen to vary by race and prenatal care type (private vs. public), with racial discrimination most strongly associated with increased depressive symptoms among non-Hispanic Black persons and in those attending public prenatal care clinics.^{91,119} Two studies did not find a significant association between racial discrimination and psychosocial wellbeing or depressive symptoms.^{113,120}

The effect of discrimination based on identity characters other than race and ethnicity or general discrimination on maternal mental health outcomes was examined in two studies. A study of general discrimination, found it to be associated with greater symptoms of depression.¹⁰¹ A study of pregnancy discrimination in the workplace found pregnancy discrimination was associated with postpartum depression symptoms mediated by maternal stress.⁹⁶

Maternal Health Behaviors. The impact of discrimination on maternal health behaviors was assessed in two studies, both of which measured general discrimination rather than discrimination based on a single identity characteristic. These studies found general

discrimination was associated with cigarette smoking, alcohol use and poorer overall sleep quality.^{101,55}

Maternal Physical Health. Few studies have examined the association of discrimination with risk of diseases of pregnancy. The two studies examining the impact of discriminations on risk of diseases of pregnancy produced conflicting findings. While Macgregor et al. found pregnant persons experiencing high general discrimination were more likely to develop gestational diabetes, Grobman et al. observed no such association between discrimination and hypertension in pregnancy.^{115,104}

Although little research has been conducted investigating the influence of discrimination on physical diseases of pregnancy, studies of physical indicators of health may provide additional information on the relationship between discrimination and maternal physical health. Four studies examined the association of maternal experiences of racial discrimination with stress indicators of: cortisol levels, leukocyte glucocorticoid sensitivity, systematic inflammation and Epstein-Barr virus reactivity.^{114,120,121,122} Each of these studies found a significant association between racial discrimination and heightened stress indicators, with associations found to vary by total life course stress and stress response.^{120,114}

Discussion Review Findings. Review of literature produces mixed results for the effect maternal discrimination on neonatal and maternal outcomes. Studies of gestational age and birth weight provided substantial evidence that maternal discrimination is linked to adverse neonatal outcomes, particularly for infants of non-Hispanic Black birthing persons. Methodological variability may explain inconsistencies in findings, as studies varied in study design, sample size, and measurement of discrimination. Studies utilized diverse measures of discrimination differing in the assessment of discrimination frequency, pervasiveness, or emotional impact, the

individuals' relation to discrimination (firsthand vs. vicarious), period (lifetime vs. past year vs. everyday experience) and life stage at which discrimination occurred (childhood, adolescence, and adulthood). Studies also varied in the timing of measurement, assessing discrimination during pregnancy, postpartum or 2 to 10 years following giving birth.

Research examining the potential impacts of maternal discrimination on maternal health during pregnancy and postpartum is less robust, however this gap may be closing as studies of maternal health become more numerous. The first study of discrimination and maternal health was published in 2010 and there has been a consistent stream of studies since then. Evidence of an association between discrimination and maternal health is strongest for mental health outcomes. This is consistent with trends in overall health disparity research. Only two studies investigated the effect of discrimination on diseases of pregnancy. Further research is needed to uncover to what extent maternal discrimination impacts diseases of pregnancy.

Reviewed studies concentrated almost exclusively on measuring racial discrimination. The few studies of discrimination based on other identity characteristics suggest these forms of discrimination may also affect maternal and neonatal birth outcomes. Further research capturing the impact of discrimination based on multiple identity characteristics on perinatal health outcomes is needed.

Discrimination Research, Focus on a Single Dimension

Researchers have typically focused on discrimination based on a singular identity, most commonly racism. This practice is criticized for neglecting the multiple identity characteristics (ex. gender, age, sexual orientation, socioeconomic status, religion, weight etc.) and corresponding oppression that shape an individual's experience in society.¹²³ Prior research has tended to focus on African Americans as a monolith, precluding consideration of within group

heterogeneity in discrimination experiences and subsequent health impacts. A singular focus likely underestimates the overall impact of discriminatory stressors on the health of African Americans. A unidimensional framework is insufficient to assess discrimination experiences of those with multiple minority statuses.^{124,125} A singular focus on maternal discrimination attributed to race, likely masks important complexities in Black mother's discrimination experiences and underestimates the impact of discrimination on birth outcomes. An approach that captures a broader range of complexities in the study of maternal discrimination is warranted.

An Intersectionality Perspective

The term intersectionality was coined by critical legal race scholar Kimberle Williams Crenshaw, and was initially applied in understanding how social categories of race and gender interact to constitute the lived experiences of Black persons.¹²⁶ Rooted in Black Feminist theory, an intersectional framework promotes the understanding of individuals as multi-dimensional and complex, shaped by intersections of multiple social identities and interlocking power structures. Social identities such as race, gender, age, disability and sexual orientation are conceptualized as interacting and co-constituting one another to create one's unique social location and experiences.^{127,128}

Utilization of an intersectionality approach is a priority of future research on racism and health (William et al., 2019). An intersectional perspective suggests discrimination against multiple marginalized identities takes unique forms that cannot be fully understood within the context of a single mode of oppression. An adaptation of Lewis and Van Dyke's (2018) framework for how race interacts with other social identities to shape discrimination and thus health is displayed in Figure 1.¹²⁴ Depicted by this framework is the influence of an individual's

intersecting social location on the quantity and character of discrimination in which they are exposed and consequential effects on health. An intersectionality approach may be particularly useful in examining the complex discrimination experience of Black pregnant persons that contribute to marked disparities in birth outcomes.¹²⁹ Promotion of equity in perinatal health will require researchers capture the heterogeneity present in pregnant persons' experience of discrimination contributing to disparities in maternal and neonatal birth outcomes.

An Alternative Model of Prenatal Care (Manuscript Two)

Strategies to Reduce Black-White Disparities

A twelve-point plan to reduce Black-White disparities in birth outcomes taking a life course approach has been proposed and incorporated into national strategy.^{130,131,132} A life course perspective suggests to substantially impact perinatal health, interventions must be expanded across the life span. Simply addressing preexisting medical conditions upon arrival at prenatal care or delivery will likely not be sufficient to prevent adverse maternal and neonatal outcomes.¹³¹ Lu et al's twelve-point plan addresses three overarching goals: improve quality healthcare for African American persons across the lifespan, enhance African American families and communities influencing the health of pregnant persons and address social and economic inequities that disproportionately burden African American persons over the life course. Their plan advocates for a paradigm shift that expands our perspective of birth outcome interventions across birthing persons' lifespans, to include their support systems and to address structural inequities.

Access to Prenatal Care

Though insufficient on its own, quality prenatal care is a vital component in the reduction of racial disparities in birth outcomes. Prenatal care serves as both a crucial step in a mother's

continuum of care and in a child's developmental trajectory.⁵⁹ While racial and ethnic gaps in prenatal care access have narrowed over past decades, little has been done to close the racial gap in prenatal care quality.¹³³ While increased adequacy of prenatal care measured by the month prenatal care began and the number of prenatal care visits attended, has been shown to decrease preterm birth among both Black and White pregnant persons, increased adequacy of prenatal care is associated with widening Black-White disparities in birth outcomes. It is hypothesized that differing care quality due to clinician bias and structural racism may account for these findings.¹³⁴

Quality of Prenatal Care

Care quality is described by the Institute of Medicine as composed of six aims, being safe, effective, patient centered, timely, efficient, and equitable.¹³⁵ Black and White pregnant persons are not treated equally when seeking care, 1 in 10 Black pregnant persons report experiencing poor treatment due to their identity compared to just 1 in 100 White.¹³⁶ Guidelines for prenatal care in the US have remained relatively unchanged over the past decades despite rapid advances in technology. The current prenatal care schedule recommendation of 12 to 14 one-on-one visits has been maintained since its introduction in the 1930s, with little supporting evidence. Reflection on prenatal care practices during the upheaval in care brought on by the COVID-19 pandemic, have amplified calls for prenatal care guidelines to be reconsidered in light of the evidence gained over the past century.¹³⁷ Prenatal care visit content, timing and delivery must advance in conjunction with evidence, to address mechanisms underlying racial disparities in perinatal health.¹³⁸

Prenatal Education. Studies report conflicting findings on the equal provision of prenatal education in prenatal care. While an older study found Black pregnant persons were less

likely to receive prenatal education, a more recent study reports Black pregnant persons of low socioeconomic statuses are more likely to receive prenatal education compared to White.¹³⁹¹⁴⁰ This discrepancy may represent increased targeting of prenatal education to minorities and disadvantaged groups. Despite increased prenatal education provision, low income racial and ethnic minority patients continue to report a lack of adequate prenatal education in prenatal care.¹⁴¹

Ancillary Services. Quality of care is also determined by the availability of ancillary services. While the mode and schedule of prenatal care visits has not been revised in decades, many pregnant persons have sought adjuncts to the traditional prenatal care model. Due to the brief nature of traditional one-on-one prenatal care appointments, pregnant persons are often encouraged by their providers to seek adjunct services in addition to attending prenatal care including prenatal education classes, nutrition and psychosocial supports.¹⁴² Access to adjunct prenatal care services is not equally distributed, Black mothers are two times less likely to participate in adjunct prenatal education classes than White.¹³⁰ Financial and transportation issues have been indicated as barriers to obtaining adjunct services when not offered on site or covered by medical insurance.¹⁴²

An Alternative Prenatal Care Model: Group Prenatal Care

Alternative prenatal care models may offer promise in the improvement of prenatal care quality particularly among Black pregnant persons. Standard individual prenatal care (IPNC) takes place in a one-to-one visit between the provider and patient, following the ACOG recommended schedule of; monthly visits until 28 weeks, bi-weekly from 28 to 36 weeks and then weekly until delivery.¹⁴³ On average IPNC visits last 10 to 15 minutes, resulting in only 2 to 3 hours spent in prenatal care over the course of pregnancy. Group prenatal care (GPNC) offers

an alternative to standard IPNC, delivering prenatal care components in a group setting.

CenteringPregnancy (CP) is the most well-known form of GPNC in the US.¹⁴⁴ CP GPNC was founded by nurse-midwife Sharon Schindler Rising in the 1990s with roots in the Minnesota Childbearing and Childrearing Center.¹⁴⁵ The model is built on theoretical perspectives of feminism, the midwifery model, social support theory and self-efficacy theory.¹⁴⁶

CenteringPregnancy

CP delivers the three major components of prenatal care: physical assessment, education, and support in a group setting.¹⁴⁵ The model is founded on thirteen essential elements of effective group structure, shown in Figure 2.¹⁴⁶ Approximately 8 to 12 patients with similar due dates meet for 2 hours 8 to 10 times over the course of pregnancy following the same schedule as IPNC visits. Group sessions are facilitated by a midwife, obstetrician, nurse practitioner or other maternity care provider, assisted by a co-facilitator, a nurse, social worker or other medical professional. In this model, pregnant persons receive between 12 and 20 hours of prenatal care, compared to the 2 to 3 hours estimate in IPNC.¹⁴⁵ During the first 30 minutes of the group session a clinician conducts a brief physical assessment and routine ultrasound for each patient in the group space. Concurrently pregnant persons who are not being examined, socialize, complete worksheets connected to that day's discussion and perform self-assessments including measurement of weight and blood pressure. The remaining 90-minutes are spent in facilitated discussion, centered around health education topics relevant to group members' gestational age. A facilitative leadership style is taken, and group is conducted in a circle to encourage sharing and education to flow between group members as well as from provides. Group facilitators balance planned educational content with group generated discussion, shaping the content to group needs. A list of the discussion topics outlined in the facilitators guide is shown in Figure

2.¹⁴⁷ Facilitators and group members are consistent throughout the 10-sessions, to encourage the formation of relationships and trust within the group. A support person is encouraged to join patients in group, though it is not required.¹⁴⁶

CenteringPregnancy Adoption

CP has been adopted across the US, as well in a number of countries worldwide including the United Kingdom, Australia, Sweden, Canada, Iran, Malawi and Tanzania, as well as others.^{148,149,150,151,152,153} The CP model has been expanded to include sexual health learning modules (CenteringPregnancy Plus), altered to care for specific health conditions in pregnancy and adapted to meet the needs of diverse health systems and cultures.^{154,155,156} The Centering Healthcare Institute (CHI) reports CP groups have been implemented at 582 sites in 46 states in the US, with an estimated 60,000 patients receiving CP each year.¹⁵⁷ Despite these successes, as of 2012 only 3% of pregnant persons in the US had access GPNC.¹³⁶ Strong evidence is critical for the expanded implementation of GPNC models.

The Effect CenteringPregnancy and Group Prenatal Care

The effects of CP have been studied for outcomes of patient satisfaction and care attendance, as well as numerous maternal and infant birth outcomes including preterm birth, low birth weight, neonatal intensive care unit (NICU) admission, psychosocial health, reproductive health, breastfeeding, immunizations and subsequent child-development.¹⁵⁸ A Cochrane review of RCTs comparing GPNC to standard IPNC was conducted in 2015.¹⁵⁹ Four RCTs were included in this review, two conducted in the US, one in Iran, and one in Sweden.^{160,161,152,150} Primary outcomes compared were gestational age at birth, infant birth weight and perinatal mortality. The Cochrane review concluded the four available RCTs suggested GPNC was

associated with comparable neonatal and maternal outcomes to standard IPNC and resulted in greater patient satisfaction.

A recent review of RCTs published through 2020 produced similar findings.¹⁶² Liu et al., reviewed five RCTs, four of which were conducted in the US and one conducted in Iran.^{160,163,161,164,165,166,152} As in the earlier Cochrane review, Liu et al., concluded available RCTs suggest CP performs similarly to standard IPNC with no evidence of adverse effects. GPNC was found to reduce postpartum depression compared to IPNC though these effects were no longer present one year postpartum.

A Review of Randomized Control Trials of Group Prenatal Care

The RCTs reviewed in these reports will be described alongside recent contributions to the field. A search of RCTs comparing GPNC to IPNC in the years following Lui et al.,’s review uncovered two additional RCTs conducted in the US and four additional RCTs conducted in countries outside the US.^{167,154,155,156,168,153,169,170,171,172} This search was executed in two databases, the Web of Knowledge and Medline for articles published in 2020 to present. Search terms included: “CenteringPregnancy” OR “group prenatal care” OR “group care” AND “Randomized Controlled Trial” OR “RCT”. GPNC RCTs conducted in the US will be reviewed first followed by RCTs conducted outside the US. Studies and outcomes examined are shown in Table 5.

Randomized Controlled Trials in the US. To date, six RCTs of GPNC have been conducted in the US. Three original articles were follow ups from earlier publications studying the same participants but examining different outcomes.^{163,165,154} Characteristics of the nine US studies are shown in Table 6. The first RCT was published in 2007.¹⁶⁰ RCTs were conducted at hospital and community affiliated clinics, or health centers located across the US. In one RCT

randomization occurred at the clinic level, while others randomized at the patient level.^{164,165}

Preterm birth, low birth weight, maternal depression symptoms, postpartum depression symptoms and care satisfaction were the most commonly examined outcomes. Trials were conducted among young pregnant persons, military families, those with low-medical risk, and with diabetes. Trials within each of these groups will be described.

Young Pregnant Persons. Two RCTs of GPNC have been conducted among samples of young pregnant persons, 14 to 25 years old.^{160,163,164,165} Young pregnant persons have been a target of GPNC due to the unique psychosocial vulnerabilities faced by young mothers.¹⁴⁴ These studies have included samples of 1,047 and 1,148 medically low risk pregnant persons between the ages of 14 and 25 or 14 and 21 years old. RCTs among young pregnant persons suggest GPNC may offer some benefits for neonatal birth outcomes and maternal psychosocial health. Ickovics et al., found GPNC patients were significantly less likely to deliver infants preterm, a finding that was more robust when examined only among African American participants.¹⁶⁰ GPNC patients were also found to be less likely to have suboptimal prenatal care and more likely to be satisfied with care, have greater pregnancy knowledge and higher rates of breastfeeding initiation. Examination of maternal psychosocial health found no benefit of GPNC among the overall sample, however among young pregnant persons with the greatest stress in early pregnancy, GPNC patients had significantly better psychosocial functioning in later pregnancy and postpartum.¹⁶³ In a cluster RCT, increased attendance at GPNC sessions was associated with lower odds of having small for gestational age, preterm, low birth weight infants and fewer days in the NICU.¹⁶⁴ Additionally, young pregnant persons assigned to GPNC showed a greater reduction in perinatal depressive symptoms from early pregnancy to postpartum when compared to IPNC patients.¹⁶⁵

Military Families. Military populations have also been the target of GPNC trials, as pregnant persons in the military are thought to have increased vulnerability due to a lack of usual support systems and increased stress.¹⁴⁴ Two RCTs have been conducted among medically low risk pregnant persons receiving prenatal care in military settings.^{161,166} RCTs of GPNC within military samples have been relatively small in size including 129 to 322 patients. Findings of GPNC among military families are mixed. Kennedy et al., found no effect of GPNC over that of IPNC in reducing adverse neonatal and maternal health outcomes including infant birth weight and maternal depressive symptoms, though GPNC patients were more likely to receive adequate prenatal care and were more satisfied with the care received.¹⁶¹ By contrast, Tubay et al., found GPNC was associated with an increased likelihood of infant birth weight appropriate for gestational age but not greater overall care satisfaction. Care models were found to perform similarly for outcomes of maternal depression, anxiety and breastfeeding initiation.¹⁶⁶

Low Medical Risk. Five out of six randomized control trials of GPNC in the US were conducted among medically low risk samples.^{160,163,161,166,167} Crockett et al., examined the effectiveness of GPNC among medically low risk patients 14 to 45 years old.¹⁶⁷ This trial had the largest sample to date with 2,350 patients. In contrast to some earlier RCTs, GPNC patients in this study were not found to have a lower risk of preterm birth or low birth weight infants when compared to patients receiving IPNC, nor was a prenatal care by race and ethnicity interaction observed for these outcomes. These findings were consistent when analyzed across intuition-to-treat, modified intuition to treat and per compliance samples. Exploratory analysis did however suggest GPNC may be associated with a reduction in Black-White disparity for preterm birth and low birth weight, though further study is required.

Diabetes. While other RCTs have been conducted among healthy pregnant persons, the effectiveness of GPNC among pregnant persons with type 2 diabetes and gestational diabetes was investigated in a pilot study.^{154,155} Examination of diabetes GPNC among a small sample (n=84), suggests a potential benefit of GPNC for pregnant persons with diabetes among a few of the outcomes studied. Patients receiving GPNC reported increased diabetes specific peer support, increased consumption of recommended fruit and vegetables and increased likelihood of receiving postpartum glucose tolerance tests compared to those receiving IPNC. Other measures of diabetes self-care and management including A1c, as well as measures of maternal and neonatal health were similar between care arms.

Randomized Controlled Trials of Group Prenatal Care Outside the US. To date seven RCTs of GPNC have been conducted outside of the US, one in Iran, one in Sweden and four in African nations including Nigeria, Kenya, Senegal, Malawi, Tanzania and Rwanda.^{152,150,156,168,153,169,170,171,172} Characteristics of GPNC RCTs conducted outside the US are shown in Table 7. More than half were cluster RCTs, with health center or clinician as the unit of randomization.¹⁵²¹⁵⁰¹⁵⁶¹⁷² Several had an implementation focus and assessed the feasibility of GPNC within the new context. RCTs in the African region, adapted the GPNC model to national focused antenatal care model recommendations of four prenatal care visits and catered content to regional maternal, child health concerns (ex. Malaria and HIV). The most commonly assessed outcomes were adequacy of prenatal care, postnatal care visit attendance and breastfeeding. In all cases with the exception of Sayinzoga et al. which included only patients attending two or more visits, intention-to-treat analysis was used.¹⁷²

When tested in Iran, the GPNC model was associated with greater infant birth weight and reduced caesarean section when compared to IPNC, though other birth outcomes (preterm birth

and low birth weight) were similar across care models. GPNC patients also demonstrated greater perinatal health behavior than IPNC patients including multivitamin and iron supplement use, use of contraception postpartum and breastfeeding.¹⁵² The RCT of GPNC in Sweden did not find greater overall care satisfaction among GPNC patients when compared to those receiving IPNC, however GPNC patients did report higher care satisfaction for supportive contact with other parents and initiation or breastfeeding.¹⁵⁰ In African regions, RCTs of GPNC found GPNC to be associated with improved adequacy of prenatal care (prenatal and postnatal care attendance, birth planning, care quality and care satisfaction), benefits to maternal mental health (greater self-efficacy, higher pregnancy-related empowerment, and lower mental distress), increased sexual health knowledge, and increased breastfeeding, yet did not find benefits of GPNC for neonatal outcomes.^{156,168,153,169,170,171,172}

Discussion of Review Findings. In the US, trial samples have included primarily low risk pregnant persons, though the study of GPNC among pregnant persons with health conditions in pregnancy is emerging. RCTs comparing GPNC to IPNC provide some evidence of an enhanced effect of GPNC on neonatal birth outcomes, maternal psychosocial health, care satisfaction and attendance but these findings are inconsistent. RCTs of GPNC conducted outside the US provide similarly mixed results. Two of the seven RCTs conducted in the US and abroad investigating preterm birth find positive effects of GPNC. Three of the eight studies find an effect for birth weight. Two of the six find a reduction in perinatal and postnatal depression symptoms among patients attending GPNC. Variance in trial sample size may account for some of the inconsistency observed. Trials suggest GPNC does not contribute to increased harm over IPNC. Findings of GPNC's impact on care satisfaction and visit attendance are more robust. Four of the six RCTs find GPNC is associated with enhanced satisfaction and six of the eight

studies find improved adequacy of prenatal care. These findings suggest GPNC represents a feasible and acceptable alternative to standard care models within and outside the US.

Limitations of Randomized Control Trails of Group Prenatal Care

Although RCTs are the gold standard for evaluating intervention effectiveness, RCTs of GPNC may not capture the full extent of effects. RCTs may dilute the impact of GPNC on neonatal and maternal birth outcomes, particularly when conducted in restricted populations and measured using intention-to-treat analysis.^{164,173} RCTs of GPNC have typically included healthy participants, excluding pregnant persons with preexisting conditions and pregnancy complications. The effect of GPNC may be underestimated when examined only among pregnant persons of low medical risk as GPNC may offer the most benefit among high-risk groups.¹⁷³ Additionally, Intention-to-treat analysis may ignore the role of intervention dose. Treatment compliance which has typically been measured as participation in five or more GPNC sessions is associated with increased intervention effect compared to attendance at less than five sessions.¹⁷⁴ In RCTs, around 20% of pregnant persons assigned to GPNC do not attend a single GPNC session and others attend less than five visits.^{164,165,167} While some RCTs have sought to account for participant compliance through as-treated analysis, comparisons of GPNC and IPNC by dose of treatment received are made challenging by structural differences between the models and the often “mixed” care received by pregnant persons assigned to GPNC. Observational studies of GPNC may offer additional information on model effectiveness.

A Review of Large Observational Studies of Group Prenatal Care

Observational studies typically allow patients to select their preferred model of prenatal care. Pregnant persons who choose to participate in GPNC may differ significantly from those that select IPNC. For instance, they are potentially more likely to be motivated to make healthy

behavior changes. In recent years, several observational studies of GPNC have been conducted among large diverse samples of pregnant persons. These studies attempt to account for self-selection bias through propensity score matching and other analytical methods. While propensity score matching cannot fully account for self-selection bias, as unmeasured factors may influence choice of prenatal care, these methods reduce observable group differences allowing for more rigorous comparisons.

Study Characteristics and Methods. Five large observational studies of GPNC have been conducted utilizing propensity score matching techniques.^{174,175,176,177,178} The characteristics of these studies are shown in Table 8. Four of the five studies utilized retrospective cohort designs, the fifth study utilized a type 1 hybrid effectiveness implementation trial design. Participant samples were less restrictive than in RCTs generally including pregnant persons entering care by 24 weeks, with singleton pregnancies and had no prior history of preterm birth. One study assessed the effect of GPNC among “high risk” pregnancies in which pregnant persons had one or more pregnancy complications.¹⁷⁷ Overall, intervention groups received either CP or Expect With Me a GPNC model similar to CP that incorporates connection with group members and providers between group sessions via a social media platform.¹⁷⁹ In each study, GPNC patients were matched to similar IPNC patients using propensity score matching or augmented inverse probability weighting methods. Matches were made based on between 5 and 25 demographic, medical history, and care factors.^{174,178} Three of the five studies analyzed both intention-to-treat or any exposure (≥ 1 GPNC sessions) and as-treated or minimum threshold samples (≥ 1 GPNC sessions) to account for GPNC compliance. Studies assessed the effect of GPNC on outcomes of infant preterm birth, low birth weight and NICU admission.

Study Findings. Attending one or more GPNC sessions was found to be associated with a reduced risk of preterm birth and low birth weight in four out of five observational studies.^{174,175,124} GPNC patients attending one or more sessions were also found to be at a reduced risk of infant NICU admission in all three studies where assessed.^{175,176,177} Whereas neonatal outcomes of preterm birth, low birth weight and NICU admission were significantly improved in intention-to-treat samples, benefits were found to be greatest for GPNC patients attending five or more sessions.^{174,175,177} Racial differences in effect were examined in a single study and GPNC found to produce similar effects among Black and non-Black patients.¹⁷⁵ Dubay et al., is the only study that found GPNC performed equivalent to IPNC in all neonatal outcome measures.¹⁷⁸

Discussion of Review Findings. Observational studies of GPNC using propensity score matching, have included large and diverse patient samples, including pregnant persons with medically high-risk pregnancies. Four out of five studies suggest GPNC is associated with an improvement in one or more neonatal outcomes when compared to standard IPNC. Observational findings show greater consistency in their support of GPNCs benefits than RCT studies of GPNC. Metanalysis of GPNC that included both RCTs and observational studies have concluded GPNC was associated with a reduced incidence of low birth weight and among Black birthing persons a reduction in preterm birth.¹⁸⁰ While propensity score matching attempts to address selection bias, unobservable factors associated with both group selection and outcomes may influence the findings of observational studies in the absence of randomization. The gap in findings of GPNC ‘s effect between observational and RCTs could indicate that it is something about the individuals who select to participate in GPNC that leads to the enhanced effect of this care model.

Potential Mechanisms of Group Prenatal Care

Mechanisms contributing to improved birth outcomes in patients receiving GPNC are not well understood. GPNC literature has been criticized for a lack of clear theoretical framework outlining the chain of effects by which GPNC may take effect on maternal and neonatal birth outcomes.¹⁸¹ It's theorized that shared medical appointments such as GPNC, benefit patients through enhanced education, social support form peers, the creation of group norms of healthy behavior, increased time spent with providers and decreased social hierarchy in patient-provider relationships.¹⁸² Qualitative studies of GPNC illuminate patient perspectives of important care elements that may contribute to GPNCs effect including enhanced learning, novel peer support and improved patient-provider communication.

Enhanced Learning. GPNC patients describe receiving enhanced education in the group format, facilitated by relationships among group members, as well as with the facilitators.¹⁸³ Patients report learning together and learning from the group, gaining increased knowledge as they hear from the physician, as well as fellow patients.^{184,185,186} In-depth knowledge is gained through group members sharing experiences with their peers.¹⁸⁷ Information shared in group is made more meaningful through patient's active participation and elicitation of information.¹⁸⁶ Sharing of stories was seen to normalize concerns, provide reassurance and foster identification with peers.^{185,186,187,188} GPNC participants have described feeling empowered by the knowledge they gained through care and being more confident in their capacity to mother.^{184,187,189}

Community Support. GPNC patients describe a sense of community, belonging and friendship in GPNC.^{190,184} Patients feel supported by one another, reporting elements of emotional, instrumental, information and appraisal support.^{186,189,191} Through the exchange of stories, questions, answers and advice patients receive informational support from peers, as well

as health care providers. Through the sharing of experiences, listening and empathetic response between group members emotional and appraisal support is provided. These components work together to build positive relationships between group members and between patients and providers.¹⁹²

Patient-Provider Relationship. Additional time spent with the health care providers is a benefit of GPNC.^{191,185} Alongside bonding with other group members, GPNC participants report achieving greater trust and openness with providers.¹⁸⁶ Patients attribute enhanced communication and trust to the prioritization of relationships and mutual respect in GPNC. The enhanced patient-provider relationship was also thought to increase adherence to recommendations, reinforce positive health behaviors and elevate patients' self-esteem.¹⁸⁹ In a follow up study of CP, patients reported continued use of anticipatory guidance provided in group care as well as sustained health behavior change in areas of healthy nutrition, stress management, communication, coping skills and self-care practices three years following the intervention.¹⁹³

Stress Reduction. GPNC may lead to improved maternal and neonatal outcomes through a reduction of stress and improved health behavior change. Stress during pregnancy is a known risk factor for adverse birth outcomes, contributing both directly and indirectly to health through association with risky health behaviors.^{194,195} Social support is associated with reduced psychological distress in the perinatal and postpartum period.¹⁹⁶ Low levels of social support in pregnancy have been linked to poor maternal and infant outcomes.^{197,198} Enhanced social support offered through GPNC may reduce patient's stress during pregnancy, providing a protective buffer against stressful events.¹⁹⁷ Strong relationships between patients and their prenatal care provider is associated with reduced stress, increased satisfaction and greater adherence to clinical

recommendations.¹⁹⁹ Patient perceptions of good communication, collaboration and empowerment in the patient-provider relationship is associated with increased healthy behaviors including physical activity, nutritious eating and taking prenatal vitamins, behaviors that are shown to reduce risk of adverse birth outcomes.^{199,194} In addition to social support, the improved patient-provider relationship offered through additional time spent with providers in a facilitative group context is potential mechanism through which GPNC may benefit participants.

Clinician Level Pathways. Although to date research has primarily focused on patient level factors, GPNC may also exert effect at the clinician and systems level.²⁰⁰ Just as additional time spent with health care providers has patient level impacts, enhanced quality, and quantity of social interaction between patients and providers likely also effects clinicians and the systems in which they work. Increased social interaction with their patients may provide clinicians with a greater depth of understanding for their patients and the life circumstances in which they operate. This is particularly important as providers life experiences are often economically, socially, and culturally disparate from the patients they serve. Increased time spent with patients in the GPNC setting may reduce clinician bias improving their understating of the social determinants impacting their patient's health. Future research is needed to examine the clinician level impacts of GPNC as a mechanism for improving patient outcomes.

Group Prenatal Care and Disadvantaged Groups

Some theorize, GPNC exerts the greatest effect among patients at the greatest disadvantage.^{200,173} Previous studies have demonstrated an enhanced impact of GPNC among Black pregnant persons and those with high psychosocial distress.^{160,201,180,163,202} As previously discussed Black families bare a disproportionate burden of adverse birth outcomes in the US. This disparity can be attributed at least in part to interpersonal and systematic racial

discrimination. In light of the heightened stressors associated with being Black in the US, suspected individual and clinician level mechanisms of GPNC including stress reduction, enhanced patient-provider communication and lessened clinician implicit racial bias, might be expected to offer the greatest benefit for maternal and neonatal outcomes among this group.

Group Prenatal Care Attendance

Despite evidence of GPNC's neutral or improved effect, patient recruitment, and attendance represents a significant challenge to implementation and sustainability.²⁰³ Some patients voice concerns about receiving their prenatal care in a group setting and describe access barriers exacerbated by the group format. Patients decline GPNC due to a dislike of groups, a fear of bodily or emotional exposure in a group setting, worry over partner involvement or a lack of perceived need to change from standard one-on-one care.²⁰⁴ Patients also cite logistical concerns due to the rigidity of appointment times, the length of appointment and not being able to bring children with them to GPNC sessions.²⁰⁵ Patients have demonstrated substantial non-compliance even in the highly controlled settings of RCTs in which childcare is made available, research incentives are provided and patients receive additional follow up.^{164,167} Low patient recruitment and attendance influence the cost effectiveness of GPNC, as well as provider and staff perceptions of the model's productivity and administer buy in, effecting the care models potential to impact patient and infant outcomes.^{203,174}

Characteristics Associated with Group Prenatal Care Attendance

A small body of research has explored patient sociodemographic, psychological and lifestyle characteristics associated with interest and attendance in GPNC.^{206,207,208,209,210,211} Description of these six studies is shown in Table 9. These studies employed cross sectional survey designs or utilized data from larger RCTs. Findings of characteristics associated with

interest or attendance in GPNC are inconsistent. Being primigravid and younger adolescents, having greater educational attainment, not yet having discussed labor with one's care provider, and valuing pregnant patients centeredness in care were found to be associated with interest in GPNC participation.^{206,207} Adolescents who smoked or who desired their pregnancy were more likely not to be interested in GPNC participation.²⁰⁶ By contrast another study of pregnant patients' reported likelihood of participating in GPNC found no difference in characteristics of patients reporting low, moderate, or high likelihood of participation in GPNC.²⁰⁸ Being born outside the US, nulliparous, aged 22-26, co-habiting and unmarried, having average or high stress and smoking in early pregnancy were associated with greater GPNC attendance.^{209,210,211} Lower family support, quitting smoking prior to prenatal care intake and having below average lifestyle and pregnancy knowledge was associated with less GPNC attendance.^{210,211}

While GPNC appeals to some patients, not all patients will be interested in GPNC and some face barriers to attending GPNC. Elucidation of characteristics associated with GPNC participation as well as an understanding of barriers to patient attendance can inform recruitment and model adaptation, thereby broadening the reach of GPNC. Further research is needed examining the determinants of GPNC attendance within large, randomized samples and utilizing sophisticated conceptualizations of attendance patterns. Understanding whom the GPNC model attracts and what patients are benefited through participation in GPNC is essential to successful model implementation.

Health Information Online During Pregnancy (Manuscript Three)

Groups On and Offline

There are numerous online forums dedicated to pregnant persons, want to be pregnant or recently gave birth. These forums facilitate peer-to-peer communication, allowing users to post

new messages or responded to the messages of others. These online spaces for group discussion are not unlike offline communities for pregnant persons, such as formed in GPNC. Indicated in both on and offline groups are components of formal and informal information sharing, identification with peers, reassurance, normalization and social support. While similar, there are also a number of distinctions between on and offline pregnancy communities. Online forums may offer advantages over offline groups in terms of convenience, immediacy and the relative anonymity provided. In contrast to GPNC, online pregnancy forums are not facilitated by healthcare providers. This lack of oversight in online forums may introduce concerns related to the credibility and accuracy of the information shared. Understanding pregnant persons' use of online resources during pregnancy has only become more important considering the increased prominence of the internet as a source of health information during this period.

Pregnancy in the Age of the Internet

The internet has become a popular source of health information for pregnant persons, with 94-97% reporting internet use for this purpose.^{212,213,214,136} Many pregnant persons report reading pregnancy related information online once a week or more.²¹⁵ Internet use during pregnancy many vary by subgroup. Rates of internet use during pregnancy are slightly lower among racially diverse inner-city populations (70.8%), likely due in part to challenges accessing the internet.²¹⁶ The prevalence of internet use during pregnancy has prompted investigation into motivational factors.

Motivations for Internet Use During Pregnancy. The accessibility and immediacy of information, anonymity afforded online and challenge of making an appointment with a health care provider influence pregnant persons to seek out health information online.^{216,217} Pregnant persons report commonly searching for information before and after appointments for prenatal

care, and to meet needs between appointments.^{212,213,214,218} Internet searches were reportedly used to supplement, as well as to corroborate information provided by health professionals.^{212,215} Pregnant persons commonly turned to the internet when information provided by health care providers was insufficient or unclear and due to feeling as if their provider was too busy or that they lacked time to receive answers to their question during prenatal care visits.^{212,213} They used the internet during pregnancy to find out information on their own, in order to gain the confidence to address health care providers as an equal.²¹² In particular, Low-income African American pregnant persons reported using the internet to prepare for prenatal care appointments commonly readying themselves to interrogate their provider.²¹⁹

Credibility and Influence on Decision Making. The majority of pregnant persons consider pregnancy related information found on the internet to be useful or somewhat useful.^{212,220,221} More than half of pregnant persons surveyed reported the internet influenced their thinking on how their pregnancy and birth should be managed.²¹² Confidence in decision making related to pregnancy was found to increase following internet use.²²¹ Half of pregnant persons report trusting pregnancy related information found on the internet.²¹⁴ Pregnant persons also recognized a need for caution in searching and reading pregnancy information found online and reported assessing information credibility by comparing across sites.^{213,217} Information found online has a marked effect on many pregnant persons' decisions in pregnancy despite concerns about the credibility of information.

Online Pregnancy Forums

Pregnant persons searching for pregnancy information online are likely to encounter online discussion forums even when not explicitly seeking them out. The majority of pregnant persons locate internet sources using search engines such as google, which when using natural

language queries are likely to generate links to forum posts.^{212,222} Communication in online forums is primarily text-based. Conversations are organized in a tree like structure, with each thread displaying the original post and subsequent responses in reverse chronological order. Many of these forums are publicly viewable but require registration under a pseudonym to post. Online discussion forums often bring a large and varied community together, providing pregnant persons opportunities to hear first-hand accounts from peers. Engagement in online pregnancy forums can provide pregnant persons with reassurance that they were not alone, normalizing their experiences and reducing worry.^{213,217} Online forums offer a space for pregnant persons to give and receive support, when traditional sources of support are inadequate.²¹³

While perceptions of internet sources are primarily positive, pregnant persons also report negative impressions. Some pregnant persons report online searches provoke increased worry, with online discussion forums being the most frequent source of worry.²¹⁵ At times, posts were perceived as fear mongering, relaying horror stories of extreme or worst-case scenarios of pregnancy and provoking increased anxiety in readers.^{217,213} Pregnant persons also reported information overload when searching for pregnancy information online, with the vast and sometimes contradictory content prompting feelings of frustration and overwhelm.^{223,213} Despite negative aspects, for many pregnant persons the ease in which information can be accessed online and wealth of information available make the internet an attractive outlet to fulfil needs not met through prenatal care.

Analysis of User Generated Content. While researchers have analyzed the use of online pregnancy forums through traditional qualitative and quantitative techniques, the archival nature of online content provides an opportunity for direct post analysis. Self-reported internet use may differ from what is born out in the online content itself. User generated online content is

abundant and has high rate of production. Analysis of online content can be resource saving, reducing cost, time and participant burden compared to traditional means. Content is naturally occurring, emerging without prompting for researchers or in many cases an awareness that content will be subsequently examined. This method can provide access to difficult to reach populations who would otherwise not participate in traditional research approaches such as interviews.²²⁴ The relative anonymity provided online may lead to greater openness and freedom of speech, facilitating discussion of sensitive topics.^{225,226}

While content analysis offers several advantages, there are also challenges inherent to this method, including limitations in demographic information available and ambiguity of ethical guidelines. Due to the anonymity provided in online forums, demographic information characterizing study samples is often not available. Debate has emerged in the transfer of offline ethical research standards to the online environment. Key ethical issues include determining whether an online community constitutes a public or private space, whether informed consent needs to be obtained and for whom and how and the extent to which anonymity should be protected.^{227,228} While requiring navigation of emerging research ethics, user generated content online can serve as a rich and valuable source of information. Several studies have been conducted analyzing content shared in online pregnancy discussion forums.

A Review of Studies Analyzing User Generated Content in Online Forums

A review of the literature analyzing user generated content in online pregnancy forums uncovered twenty-seven studies. A systematic search of the Web of Science database was performed using the search terms "online" OR "virtual" AND "forum" OR "message board" OR "discussion group" AND "pregnancy" OR "pregnant" OR "perinatal" OR "postpartum" and reference lists of already retrieved papers reviewed. Articles were eligible for inclusion if they

reported original research, were published in English and the full text was accessible. Articles were excluded if they focused on groups other than pregnant or postpartum persons, did not involve analysis of user generated content and if they involved the analysis of content not made in an online forum dedicated to pregnancy for example posts made to individuals Facebook page or twitter feed. A description of the included studies is shown in table 10.

Study Characteristics. Studies were published between 2008 and April 2022.^{229,230} Studies were primarily published in the past decade, with fourteen published between the years of 2010 and 2019 and twelve between 2020 and May 2022. Online forums are often accessible across multiple nations. A single study restricted the sample to posts made by users within a specific region, this region was Nova Scotia.²³¹ The majority of forums were selected using English language search terms and therefore captured online pregnancy forums popular in the United States, Canada, United Kingdom and Australia. In addition to English, forums were also located through searches in Swedish, Norwegian and Korean.^{232,229} Studies examined online forums including Babycenter (n=8), Netmums (n=3), Mumsnet (n=3), WhattoExpect (n=2), Barnimagen (n=1) and MomsholicaBaby (n=1), as well as Reddit pregnancy related subreddits (n=2). Other studies intentionally did not name the online forums where data was collected to enhance the privacy of posters (n=9).

Study Samples. Online forums of study were selected based on forum focus, popularity, and privacy characteristics. Forums were primarily identified through key word searches in search engines in keeping with study focus. Online forums identified by search engines were then assessed for popularity and user engagement, with some studies employing website analytic tools to assist in selection. All online forums were viewable to non-members and identified usernames by pseudonyms. Some studies also required permission from forum moderators prior

to inclusion and one study posted a notice informing forum users of the nature of the study and their ability to remove posts at the top of the forum.²³³ Following selection of a single or multiple online pregnancy forums to examine, some studies further refined posts for inclusion using keyword searches or based upon subforum title. Where further narrowing was needed posts were randomly selected or the first subset of posts was analyzed. While many studies included both initial and response posts in analysis, three studies only analyzed initial posts in each thread.^{234,235,236} The number of posts included in analysis varied from 71 to 262,238 posts.^{237,236}

Populations of Interest. Populations of interest varied greatly across studies. Four studies targeted general pregnancy or postpartum posts.^{238,239,236,240} While other studies targeted population subgroups by age (young mothers), parity (first and second-time moms), sexuality (lesbian mothers), mode of delivery (vaginal birth after cesarean and vaginal breech birth), current or previous birth trauma (pregnant following a pregnancy loss and pregnancy termination due to fetal anomaly), feeding method (breastfeeding and pumping), physical, mental and behavioral health conditions (pelvic girdle pain, urinary tract infection, muscular sclerosis, pelvic organ prolapse, post-childbirth maternal morbidities, perinatal depression and opioid use or misuse), medication use (psychotropic medication) and timeframe (COVID-19 pandemic). Study objectives broadly fall under two aims, exploring the beliefs or concerns expressed in online pregnancy forums or, examining patterns of interaction in online pregnancy forums (i.e., motivation for posting, response received, and quality of information provided).

Methods of Analysis. The majority of studies analyzed posts using manual qualitative analysis using techniques of thematic analysis (n=11), content analysis (n=9), grounded theory (n=2), discourse analysis (n=1) or a Consensual Qualitative Research Approach (n=1). Some studies also employed word frequency counts, sentiment analysis or assessed information

accuracy through comparison with guideline care.^{239,240,241} Two studies employed the natural language processing (NLP) method of Latent Dirichlet Allocation topic modeling.^{236,230} NLP techniques use algorithmic approaches to process textual data. LDA topic models detect patterns in the data, probabilistically identifying co-occurring word grouping that often correspond with recognizable themes in the data.²⁴² NLP techniques such as LDA can quickly process large amounts of data.²⁴³ Accordingly, studies employing LDA analyzed a larger number of posts than those applying manual analysis, analyzing a sample of 262,238 and 16,000 posts.^{236,230}

Study Findings. Among studies examining discussion topics in online pregnancy forums, common topics representing potential unmet information needs included maternal health particularly the physical symptoms of pregnancy and labor, baby related topics most prominently sleeping and feeding routines, and relationships with family or friends.²³⁶ Maternal and infant care remained primary topics of discussion in the postpartum period.²⁴⁴ In keeping these findings, users express a variety of questions about breastfeeding and pumping.^{245,246,247} The needs expressed by young first-time mothers posting in online forums fell into three areas, maternal wellbeing, child health and creating a positive environment to raise a child.²⁴⁸ Second-time mothers expressed overlapping, as well as distinct informational needs from first-time mothers, in relation to their new identify as a mother of two, care for multiple children and the new family dynamics following birth of their second child.²³⁰ Examination of online pregnancy forums for specific physical, mental, and behavioral health conditions, provides insight into the lived experiences of pregnant persons managing these illnesses.^{233,249,237,250,251,229,252,253} While still other studies clarified pregnant persons' beliefs and feelings concerning modes of delivery, pregnancy following loss, pregnancy termination due fetal anomaly and giving birth during the COVID-19 pandemic.^{234,235,254,232,240}

In studies investigating communication patterns among users, posters were found to be motivated to seek support online due to unmet needs offline including limited access or frustration with their healthcare provider, a lack of support and exposure to contradictory information.²³⁸ Posters sought formal and informal pregnancy knowledge from peers, often sharing stories of their own experiences.^{238,239} While posts among pregnant teens were more often directed at establishing community than acquiring pregnancy information.²⁴¹ Several studies applied social support typologies to posts. Emotional support was found to be the most common form of support displayed, with informational and instrumental support also present.^{255,256,241,231} Responses commonly normalized pregnant person's experiences whether rightfully or incorrectly.^{231,257} While few studies assessed the accuracy of information provided through peer response, one study suggests a little over half of posts offer accurate information or advice while the other half provide incomplete or inaccurate information.²³⁹ These findings illuminate the nature of engagement in online forums dedicated to pregnancy, yet a number of gaps in the literature remain.

New Techniques for the Study of Online Pregnancy Forums

Online pregnancy forums contain millions of posts generated by pregnant persons. These posts represent a largely untapped opportunity to examine the concerns pregnant persons express in anonymous online environments. Analysis of this unprompted, naturalistic content can afford access to a diverse range of viewpoints that may not have been captured using traditional methods. Prior content analysis has primarily been conducted using manual qualitative methods. A review of literature uncovered only two studies that utilized NLP methods for the analysis of online pregnancy forum posts.

Qualitative analysis and natural language processing methods each carry strengths and weaknesses. Qualitative analysis can provide thick, rich descriptions of participants thoughts, feelings and lived experiences but is often time consuming and labor intensive thus precluding analysis of vast quantities of data such as the magnitude of which is available online. Whereas NLP methods can algorithmically identify patterns in large datasets quickly but do not offer a similar level of depth and contextual understanding.²⁵⁸ An alternative could be to draw on the advantages of both by combining qualitative analysis and NLP in a mixed methods analysis. Combining NLP with qualitative analysis allows researchers to embrace the volume of data online, utilizing NLP to organize data based on research relevance followed by qualitative analysis of a subset of data.²⁵⁹ Examination of content generated by pregnant persons can identify unmet needs in this critical period, contributing to knowledge and guiding enhancement of prenatal care quality.

Dissertation Studies

This dissertation is comprised of three empirical studies. Each study addresses gaps in knowledge introduced in the preceding review of literature.

Manuscript One:

Profound racial and ethnic disparities exist in perinatal health in the US. Black birthing persons and infants face significantly higher rates of mortality and morbidity compared to White peers. A life course perspective suggests the Black-White disparity in perinatal health is the result of differential risk exposure prior to conception. Discriminatory stressors are likely one mechanism underlying worsened perinatal health. Past research has been limited by the measurement of discrimination based on a single attribute, commonly race, when in practice individuals inhabit multiple oppressed or privileged social identities simultaneously. My first

manuscript applied an intersectional framework, to the examination of maternal discrimination. Investigating whether maternal discrimination experiences distinguish latent classes of pregnant patients and whether class designation is associated with risk of adverse perinatal health, utilizing the person-centered quantitative method of latent class analysis.

Manuscript Two:

GPNC is one of few interventions suggested to enhance health equity in perinatal health at the clinic level. Research suggest GPNC may improve birth outcomes including preterm birth and low birth weight among some patients. While GPNC is a promising alternative to traditional IPNC, not all patients are interested or will benefit from receiving prenatal care in this format, as evidenced by poor compliance to GPNC in RCTs. Few studies have examined patient characteristics associated with patient GPNC session attendance. My second dissertation manuscript applied a concurrent mixed methods design to the investigation of patient and group characteristics predictive of GPNC participation.

Manuscript Three:

For many pregnant persons the desire for peer support during pregnancy bridges online. Pregnant persons frequently turn to the internet to meet unmet information and support needs. Some engage in online pregnancy discussions forums that facilitate peer to peer interaction. Analysis of the large and diverse user generated content in online pregnancy forums can provide insight into what information pregnant persons are seeking out online. My third dissertation manuscript applied the NLP technique of LDA topic modeling to investigate the dominant topics being discussed and what proportion of these topics relate to health.

References

1. Centers for Disease Control and Prevention National Center for Health Statistics National Vital Statistics System. Infant Mortality Rates. *www.cdc.gov*
<https://www.cdc.gov/reproductivehealth/maternalinfanthealth/infantmortality.htm>.
2. MacDorman, M. F. & Mathews, T. J. Understanding racial and ethnic disparities in U.S. infant mortality rates. *NCHS Data Brief* 1–8 (2011).
3. Mathews, T. J. & Driscoll, A. K. Trends in Infant Mortality in the United States, 2005–2014. *NCHS Data Brief* 1–8 (2017).
4. Centers for Disease Control and Prevention National Center for Health Statistics National Vital Statistics System. Mortality in the United States, 2020. *www.cdc.gov*
<https://www.cdc.gov/nchs/products/databriefs/db427.htm>.
5. Organization for Economic Cooperation and Development. CO1.1. Infant mortality. *www.oecd.org* https://www.oecd.org/els/family/CO_1_1_Infant_mortality.pdf.
6. Papanicolas, I., Woskie, L. R. & Jha, A. K. Health Care Spending in the United States and Other High-Income Countries. *JAMA* **319**, 1024 (2018).
7. MacDorman, M. F., Matthews, T. J., Mohangoo, A. D. & Zeitlin, J. International comparisons of infant mortality and related factors: United States and Europe, 2010. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **63**, 1–6 (2014).
8. Krieger, N. *et al.* The Fall and Rise of US Inequities in Premature Mortality: 1960–2002. *PLoS Med.* **5**, e46 (2008).
9. Ely, D. M. & Driscoll, A. K. Infant Mortality in the United States, 2018: Data From the Period Linked Birth/Infant Death File. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **69**, 1–18 (2020).
10. Raju, T. N. K., Buist, A. S., Blaisdell, C. J., Moxey-Mims, M. & Saigal, S. Adults born preterm: a review of general health and system-specific outcomes. *Acta Paediatr.* **106**, 1409–1437 (2017).
11. Saigal, S. & Doyle, L. W. An overview of mortality and sequelae of preterm birth from infancy to adulthood. *The Lancet* **371**, 261–269 (2008).
12. Delobel-Ayoub, M. *et al.* Behavioral Outcome at 3 Years of Age in Very Preterm Infants: The EPIPAGE Study. *Pediatrics* **117**, 1996–2005 (2006).
13. Botting, N., Powls, A., Cooke, R. W. I. & Marlow, N. Attention Deficit Hyperactivity Disorders and Other Psychiatric Outcomes in Very Low Birthweight Children at 12 Years. *J. Child Psychol. Psychiatry* **38**, 931–941 (1997).

14. Moster, D., Lie, R. T. & Markestad, T. Long-Term Medical and Social Consequences of Preterm Birth. *N. Engl. J. Med.* **359**, 262–273 (2008).
15. Hovi, P. *et al.* Glucose Regulation in Young Adults with Very Low Birth Weight. *N. Engl. J. Med.* **356**, 2053–2063 (2007).
16. Hack, M. *et al.* Outcomes in Young Adulthood for Very-Low-Birth-Weight Infants. *N. Engl. J. Med.* **346**, 149–157 (2002).
17. Mathiasen, R., Hansen, B. M., Nybo Anderson, A.-M. & Greisen, G. Socio-economic achievements of individuals born very preterm at the age of 27 to 29 years: a nationwide cohort study: Socio-Economic Achievements of Individuals Born Very Preterm. *Dev. Med. Child Neurol.* **51**, 901–908 (2009).
18. Petrou, S., Sach, T. & Davidson, L. The long-term costs of preterm birth and low birth weight: results of a systematic review: *Systematic review of long-term costs of preterm birth and low birth weight.* *Child Care Health Dev.* **27**, 97–115 (2001).
19. Behrman, R. & Butler, A. *Preterm Birth: Causes, Consequences, and Prevention.* 11622 (National Academies Press, 2007). doi:10.17226/11622.
20. Say, L., Pattinson, R. C. & Gülmezoglu, A. M. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). *Reprod. Health* **1**, 3 (2004).
21. Centers for Disease Control and Prevention National Center for Health Statistics National Vital Statistics System. Pregnancy-Related Deaths. *www.cdc.gov*
<https://www.cdc.gov/reproductivehealth/maternal-mortality/preventing-pregnancy-related-deaths.html>.
22. Creanga, A. A., Syverson, C., Seed, K. & Callaghan, W. M. Pregnancy-Related Mortality in the United States, 2011–2013. *Obstet. Gynecol.* **130**, 366–373 (2017).
23. Gray, K. E., Wallace, E. R., Nelson, K. R., Reed, S. D. & Schiff, M. A. Population-Based Study of Risk Factors for Severe Maternal Morbidity: Risk factors for severe maternal morbidity. *Paediatr. Perinat. Epidemiol.* **26**, 506–514 (2012).
24. Callaghan, W. M., Creanga, A. A. & Kuklina, E. V. Severe Maternal Morbidity Among Delivery and Postpartum Hospitalizations in the United States: *Obstet. Gynecol.* **120**, 1029–1036 (2012).
25. Kilpatrick, S. K. & Ecker, J. L. Severe maternal morbidity: screening and review. *Am. J. Obstet. Gynecol.* **215**, B17–B22 (2016).

26. Centers for Disease Control and Prevention. Severe Maternal Morbidity in the United States. *www.cdc.gov*
<https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html>.
27. Centers for Disease Control and Prevention. Pregnancy Mortality Surveillance System. *www.cdc.gov* <https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm>.
28. Hoyert, D. *Maternal Mortality Rates in the United States, 2020*.
<https://stacks.cdc.gov/view/cdc/113967> (2022) doi:10.15620/cdc:113967.
29. Chinn, J. J. *et al.* Maternal mortality in the United States: research gaps, opportunities, and priorities. *Am. J. Obstet. Gynecol.* **223**, 486-492.e6 (2020).
30. World Health Organization. *Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. (2019).
31. Tikkanen, R., Gunja, M. Z., FitzGerald, M. & Zephyrin, L. Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries. (2020)
doi:10.26099/411V-9255.
32. MacDorman, M. F., Declercq, E. & Thoma, M. E. Trends in Maternal Mortality by Sociodemographic Characteristics and Cause of Death in 27 States and the District of Columbia. *Obstet. Gynecol.* **129**, 811–818 (2017).
33. Campbell, K. H. *et al.* Maternal Morbidity and Risk of Death at Delivery Hospitalization: *Obstet. Gynecol.* **122**, 627–633 (2013).
34. Small, M. J. *et al.* Near-Miss Maternal Mortality: Cardiac Dysfunction as the Principal Cause of Obstetric Intensive Care Unit Admissions. *Obstet. Gynecol.* **119**, 250–255 (2012).
35. Addante, A. N. *et al.* The association between state-level abortion restrictions and maternal mortality in the United States, 1995-2017. *Contraception* **104**, 496–501 (2021).
36. Vilda, D. *et al.* State Abortion Policies and Maternal Death in the United States, 2015–2018. *Am. J. Public Health* **111**, 1696–1704 (2021).
37. Petersen, E. E. *et al.* Racial/Ethnic Disparities in Pregnancy-Related Deaths — United States, 2007–2016. *MMWR Morb. Mortal. Wkly. Rep.* **68**, 762–765 (2019).
38. Tucker, M. J., Berg, C. J., Callaghan, W. M. & Hsia, J. The Black–White Disparity in Pregnancy-Related Mortality From 5 Conditions: Differences in Prevalence and Case-Fatality Rates. *Am. J. Public Health* **97**, 247–251 (2007).

39. Metcalfe, A., Wick, J. & Ronksley, P. Racial Disparities in Comorbidity and Severe Maternal Morbidity/Mortality in the United States: An Analysis of Temporal Trends. *Obstet. Gynecol. Surv.* **73**, 337–338 (2018).
40. Howell, E. A. Reducing Disparities in Severe Maternal Morbidity and Mortality. *Clin. Obstet. Gynecol.* **61**, 387–399 (2018).
41. Howland, R. E. *et al.* Estimating the Hospital Delivery Costs Associated With Severe Maternal Morbidity in New York City, 2008–2012. *Obstet. Gynecol.* **131**, 242–252 (2018).
42. Matas, J. L., Mitchell, L. E., Sharma, S. V., Louis, J. M. & Salemi, J. L. Severe maternal morbidity at delivery and postpartum readmission in the United States. *Paediatr. Perinat. Epidemiol.* **35**, 627–634 (2021).
43. Phibbs, C. M. *et al.* A Comprehensive Analysis of the Costs of Severe Maternal Morbidity. *Womens Health Issues* S1049386721001924 (2022) doi:10.1016/j.whi.2021.12.006.
44. Riggan, K. A., Gilbert, A. & Allyse, M. A. Acknowledging and Addressing Allostatic Load in Pregnancy Care. *J. Racial Ethn. Health Disparities* **8**, 69–79 (2021).
45. Leimert, K. B. & Olson, D. M. Racial disparities in pregnancy outcomes: genetics, epigenetics, and allostatic load. *Curr. Opin. Physiol.* **13**, 155–165 (2020).
46. Schwartz, R. S. Racial Profiling in Medical Research. *N. Engl. J. Med.* **344**, 1392–1393 (2001).
47. York, T. P., Strauss, J. F., Neale, M. C. & Eaves, L. J. Racial Differences in Genetic and Environmental Risk to Preterm Birth. *PLoS ONE* **5**, e12391 (2010).
48. Acevedo-Garcia, D., Soobader, M.-J. & Berkman, L. F. The Differential Effect of Foreign-Born Status on Low Birth Weight by Race/Ethnicity and Education. *Pediatrics* **115**, e20–e30 (2005).
49. Singh, G. K. & Yu, S. M. Adverse pregnancy outcomes: differences between US- and foreign-born women in major US racial and ethnic groups. *Am. J. Public Health* **86**, 837–843 (1996).
50. Collins, J. W. Differing Intergenerational Birth Weights among the Descendants of US-born and Foreign-born Whites and African Americans in Illinois. *Am. J. Epidemiol.* **155**, 210–216 (2002).
51. Braveman, P. A. *et al.* The Role of Socioeconomic Factors in Black–White Disparities in Preterm Birth. *Am. J. Public Health* **105**, 694–702 (2015).
52. Goffman, D., Madden, R. C., Harrison, E. A., Merkatz, I. R. & Chazotte, C. Predictors of maternal mortality and near-miss maternal morbidity. *J. Perinatol.* **27**, 597–601 (2007).

53. Koning, S. M. & Ehrental, D. B. Stressor landscapes, birth weight, and prematurity at the intersection of race and income: Elucidating birth contexts through patterned life events. *SSM - Popul. Health* **8**, 100460 (2019).
54. Lhila, A. & Long, S. What is driving the black-white difference in low birthweight in the US? *Health Econ.* **21**, 301–315 (2012).
55. Goldenberg, R. L. *et al.* Medical, psychosocial, and behavioral risk factors do not explain the increased risk for low birth weight among black women. *Am. J. Obstet. Gynecol.* **175**, 1317–1324 (1996).
56. Engelhardt, K. A., Hisle-Gorman, E., Gorman, G. H. & Dobson, N. R. Lower Preterm Birth Rates but Persistent Racial Disparities in an Open-Access Health Care System. *Mil. Med.* **183**, e570–e575 (2018).
57. Lu, M. C. & Halfon, N. Racial and Ethnic Disparities in Birth Outcomes: A Life-Course Perspective. *Matern. Child Health J.* **7**, 13–30 (2003).
58. Halfon, N., Larson, K., Lu, M., Tullis, E. & Russ, S. Lifecourse Health Development: Past, Present and Future. *Matern. Child Health J.* **18**, 344–365 (2014).
59. Lu, M. C. We Can Do Better: Improving Perinatal Health in America. *J. Womens Health* **19**, 569–574 (2010).
60. McEwen, B. S. Stress and the Individual: Mechanisms Leading to Disease. *Arch. Intern. Med.* **153**, 2093 (1993).
61. Olson, D. *et al.* Allostatic Load and Preterm Birth. *Int. J. Mol. Sci.* **16**, 29856–29874 (2015).
62. Hux, V. J., Catov, J. M. & Roberts, J. M. Allostatic Load in Women with a History of Low Birth Weight Infants: The National Health and Nutrition Examination Survey. *J. Womens Health* **23**, 1039–1045 (2014).
63. Hux, V. J. & Roberts, J. M. A Potential Role for Allostatic Load in Preeclampsia. *Matern. Child Health J.* **19**, 591–597 (2015).
64. Upchurch, D. M. *et al.* A Longitudinal Investigation of Race, Socioeconomic Status, and Psychosocial Mediators of Allostatic Load in Midlife Women: Findings From the Study of Women’s Health Across the Nation. *Psychosom. Med.* **77**, 402–412 (2015).
65. Geronimus, A. T. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethn. Dis.* **2**, 207–221 (1992).

66. Geronimus, A. T., Hicken, M., Keene, D. & Bound, J. “Weathering” and Age Patterns of Allostatic Load Scores Among Blacks and Whites in the United States. *Am. J. Public Health* **96**, 826–833 (2006).
67. Diez Roux, A. V. *et al.* Race/ethnicity and telomere length in the Multi-Ethnic Study of Atherosclerosis: Race/ethnicity and telomere length. *Aging Cell* **8**, 251–257 (2009).
68. Krieger, N. Discrimination and Health Inequities. *Int. J. Health Serv.* **44**, 643–710 (2014).
69. Meyer, I. H. Prejudice as Stress: Conceptual and Measurement Problems. *Am. J. Public Health* **93**, 262–265 (2003).
70. Jones, C. Levels of racism: a theoretic framework and a gardener’s tale. *Am. J. Public Health* **90**, 1212–1215 (2000).
71. Link, B. G. & Phelan, J. C. Conceptualizing Stigma. *Annu. Rev. Sociol.* **27**, 363–385 (2001).
72. Pascoe, E. A. & Smart Richman, L. Perceived discrimination and health: A meta-analytic review. *Psychol. Bull.* **135**, 531–554 (2009).
73. Williams, D. R. Miles to Go before We Sleep: Racial Inequities in Health. *J. Health Soc. Behav.* **53**, 279–295 (2012).
74. Williams, D. R., Lawrence, J. A., Davis, B. A. & Vu, C. Understanding how discrimination can affect health. *Health Serv. Res.* **54**, 1374–1388 (2019).
75. Paradies, Y. *et al.* Racism as a Determinant of Health: A Systematic Review and Meta-Analysis. *PLOS ONE* **10**, e0138511 (2015).
76. Larrabee Sonderlund, A., Schoenthaler, A. & Thilsing, T. The Association between Maternal Experiences of Interpersonal Discrimination and Adverse Birth Outcomes: A Systematic Review of the Evidence. *Int. J. Environ. Res. Public Health* **18**, 1465 (2021).
77. Giurgescu, C., McFarlin, B. L., Lomax, J., Craddock, C. & Albrecht, A. Racial Discrimination and the Black-White Gap in Adverse Birth Outcomes: A Review. *J. Midwifery Womens Health* **56**, 362–370 (2011).
78. Alhusen, J. L., Bower, K. M., Epstein, E. & Sharps, P. Racial Discrimination and Adverse Birth Outcomes: An Integrative Review. *J. Midwifery Womens Health* **61**, 707–720 (2016).
79. Mutambudzi, M., Meyer, J. D., Reisine, S. & Warren, N. A review of recent literature on materialist and psychosocial models for racial and ethnic disparities in birth outcomes in the US, 2000–2014. *Ethn. Health* **22**, 311–332 (2017).
80. Williams, D. R. & Mohammed, S. A. Racism and Health I: Pathways and Scientific Evidence. *Am. Behav. Sci.* **57**, 1152–1173 (2013).

81. Mehra, R., Boyd, L. M. & Ickovics, J. R. Racial residential segregation and adverse birth outcomes: A systematic review and meta-analysis. *Soc. Sci. Med.* **191**, 237–250 (2017).
82. Chambers, B. D., Baer, R. J., McLemore, M. R. & Jelliffe-Pawlowski, L. L. Using Index of Concentration at the Extremes as Indicators of Structural Racism to Evaluate the Association with Preterm Birth and Infant Mortality—California, 2011–2012. *J. Urban Health* **96**, 159–170 (2019).
83. Krieger, N. *et al.* Jim Crow and Premature Mortality Among the US Black and White Population, 1960–2009: An Age–Period–Cohort Analysis. *Epidemiology* **25**, 494–504 (2014).
84. Mendez, D. D., Hogan, V. K. & Culhane, J. F. Institutional racism, neighborhood factors, stress, and preterm birth. *Ethn. Health* **19**, 479–499 (2014).
85. Dyer, L., Hardeman, R., Vilda, D., Theall, K. & Wallace, M. Mass incarceration and public health: the association between black jail incarceration and adverse birth outcomes among black women in Louisiana. *BMC Pregnancy Childbirth* **19**, 525 (2019).
86. Hardeman, R. R. *et al.* Association of Residence in High–Police Contact Neighborhoods With Preterm Birth Among Black and White Individuals in Minneapolis. *JAMA Netw. Open* **4**, e2130290 (2021).
87. Runkle, J. D., Matthews, J. L., Sparks, L., McNicholas, L. & Sugg, M. M. Racial and ethnic disparities in pregnancy complications and the protective role of greenspace: A retrospective birth cohort study. *Sci. Total Environ.* **808**, 152145 (2022).
88. Shiono, P. H., Rauh, V. A., Park, M., Lederman, S. A. & Zuskar, D. Ethnic differences in birthweight: the role of lifestyle and other factors. *Am. J. Public Health* **87**, 787–793 (1997).
89. Bower, K. M., Geller, R. J., Perrin, N. A. & Alhusen, J. Experiences of Racism and Preterm Birth: Findings from a Pregnancy Risk Assessment Monitoring System, 2004 through 2012. *Womens Health Issues* **28**, 495–501 (2018).
90. Segre, L. S., Mehner, B. T. & Brock, R. L. Perceived Racial Discrimination and Depressed Mood in Perinatal Women: An Extension of the Domain Specific Stress Index. *Womens Health Issues* **31**, 254–262 (2021).
91. Weeks, F., Zapata, J., Rohan, A. & Green, T. Are Experiences of Racial Discrimination Associated with Postpartum Depressive Symptoms? A Multistate Analysis of Pregnancy Risk Assessment Monitoring System Data. *J. Womens Health* **31**, 158–166 (2022).
92. Barber, K. F. S. & Robinson, M. D. Examining the Influence of Racial Discrimination on Adverse Birth Outcomes: An Analysis of the Virginia Pregnancy Risk Assessment Monitoring System (PRAMS), 2016–2018. *Matern. Child Health J.* **26**, 691–699 (2022).

93. Mustillo, S. *et al.* Self-Reported Experiences of Racial Discrimination and Black–White Differences in Preterm and Low-Birthweight Deliveries: The CARDIA Study. *Am. J. Public Health* **94**, 2125–2131 (2004).
94. Carty, D. C. *et al.* Racism, Health Status, and Birth Outcomes: Results of a Participatory Community-Based Intervention and Health Survey. *J. Urban Health* **88**, 84–97 (2011).
95. Rosenberg, L., Palmer, J. R., Wise, L. A., Horton, N. J. & Corwin, M. J. Perceptions of Racial Discrimination and the Risk of Preterm Birth: *Epidemiology* **13**, 646–652 (2002).
96. Hackney, K. J. *et al.* Examining the effects of perceived pregnancy discrimination on mother and baby health. *J. Appl. Psychol.* **106**, 774–783 (2021).
97. Hilmert, C. J. *et al.* Lifetime racism and blood pressure changes during pregnancy: Implications for fetal growth. *Health Psychol.* **33**, 43–51 (2014).
98. Dole, N. Maternal Stress and Preterm Birth. *Am. J. Epidemiol.* **157**, 14–24 (2003).
99. Dole, N. *et al.* Psychosocial Factors and Preterm Birth Among African American and White Women in Central North Carolina. *Am. J. Public Health* **94**, 1358–1365 (2004).
100. Dailey, D. E. Social Stressors and Strengths as Predictors of Infant Birth Weight in Low-Income African American Women. *Nurs. Res.* **58**, 340–347 (2009).
101. Bennett, I. M. *et al.* Perceived Discrimination and Depressive Symptoms, Smoking, and Recent Alcohol Use in Pregnancy. *Birth* **37**, 90–97 (2010).
102. Earnshaw, V. A. *et al.* Maternal Experiences with Everyday Discrimination and Infant Birth Weight: A Test of Mediators and Moderators Among Young, Urban Women of Color. *Ann. Behav. Med.* **45**, 13–23 (2013).
103. Francis, B., Klebanoff, M. & Oza-Frank, R. Racial discrimination and perinatal sleep quality. *Sleep Health* **3**, 300–305 (2017).
104. MacGregor, C. *et al.* Maternal Perceived Discrimination and Association With Gestational Diabetes. *Obstet. Gynecol. Surv.* **76**, 185–187 (2021).
105. Harrell, S. Psychometric properties of racism and life experiences scale (RaLES). (1997).
106. Krieger, N., Smith, K., Naishadham, D., Hartman, C. & Barbeau, E. M. Experiences of discrimination: Validity and reliability of a self-report measure for population health research on racism and health. *Soc. Sci. Med.* **61**, 1576–1596 (2005).
107. Williams, D. R., Yan Yu, Jackson, J. S. & Anderson, N. B. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *J. Health Psychol.* **2**, 335–351 (1997).

108. Bond, M. *et al.* *Expanding Our Understanding of the Psychosocial Work Environment: A Compendium of Measures of Discrimination, Harassment and Work-Family Issues.* (Department of Health and Human Services, 2007).
109. James, K., Lovato, C. & Cropanzano, R. Correlational and Known-Group Comparison Validation of a Workplace Prejudice/Discrimination Inventory. *J. Appl. Soc. Psychol.* **24**, 1573–1592 (1994).
110. Dominguez, T. P., Dunkel-Schetter, C., Glynn, L. M., Hobel, C. & Sandman, C. A. Racial differences in birth outcomes: The role of general, pregnancy, and racism stress. *Health Psychol.* **27**, 194–203 (2008).
111. Slaughter-Acey, J. C., Talley, L. M., Stevenson, H. C. & Misra, D. P. Personal Versus Group Experiences of Racism and Risk of Delivering a Small-for-Gestational Age Infant in African American Women: a Life Course Perspective. *J. Urban Health* **96**, 181–192 (2019).
112. Daniels, K. P., Valdez, Z., Chae, D. H. & Allen, A. M. Direct and Vicarious Racial Discrimination at Three Life Stages and Preterm Labor: Results from the African American Women’s Heart & Health Study. *Matern. Child Health J.* **24**, 1387–1395 (2020).
113. Giurgescu, C. *et al.* Relationships among Neighborhood Environment, Racial Discrimination, Psychological Distress, and Preterm Birth in African American Women. *J. Obstet. Gynecol. Neonatal Nurs.* **41**, E51–E61 (2012).
114. Gillespie, S. L. & Anderson, C. M. Racial discrimination and leukocyte glucocorticoid sensitivity: Implications for birth timing. *Soc. Sci. Med.* **216**, 114–123 (2018).
115. Grobman, W. A. *et al.* Racial Disparities in Adverse Pregnancy Outcomes and Psychosocial Stress. *Obstet. Gynecol.* **131**, 328–335 (2018).
116. Slaughter-Acey, J. C. *et al.* Racism in the form of micro aggressions and the risk of preterm birth among black women. *Ann. Epidemiol.* **26**, 7-13.e1 (2016).
117. Misra, D., Strobino, D. & Trabert, B. Effects of social and psychosocial factors on risk of preterm birth in black women: Social and psychosocial risk factors. *Paediatr. Perinat. Epidemiol.* **24**, 546–554 (2010).
118. Collins, J. W. *et al.* Low-Income African-American Mothers’ Perception of Exposure to Racial Discrimination and Infant Birth Weight: *Epidemiology* **11**, 337–339 (2000).
119. Ertel, K. A. *et al.* Racial discrimination, response to unfair treatment, and depressive symptoms among pregnant black and African American women in the United States. *Ann. Epidemiol.* **22**, 840–846 (2012).

120. Gillespie, S. L. *et al.* Racial Discrimination and Stress Across the Life Course: Associations With Prenatal Inflammation, Perceived Stress, and Depressive Symptoms. *Nurs. Res.* **70**, S21–S30 (2021).
121. Giurgescu, C. *et al.* Racial discrimination predicts greater systemic inflammation in pregnant African American women. *Appl. Nurs. Res.* **32**, 98–103 (2016).
122. Christian, L. M., Iams, J. D., Porter, K. & Glaser, R. Epstein-Barr virus reactivation during pregnancy and postpartum: Effects of race and racial discrimination. *Brain. Behav. Immun.* **26**, 1280–1287 (2012).
123. Cole, E. R. Intersectionality and research in psychology. *Am. Psychol.* **64**, 170–180 (2009).
124. Lewis, T. T. & Van Dyke, M. E. Discrimination and the Health of African Americans: The Potential Importance of Intersectionalities. *Curr. Dir. Psychol. Sci.* **27**, 176–182 (2018).
125. Harnois, C. E. Are Perceptions of Discrimination Unidimensional, Oppositional, or Intersectional? Examining the Relationship among Perceived Racial–Ethnic-, Gender-, and Age-Based Discrimination. *Sociol. Perspect.* **57**, 470–487 (2014).
126. Crenshaw, K. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory, and Antiracist Politics. in *Living with Contradictions* (ed. Jaggar, A. M.) 39–52 (Routledge, 2018). doi:10.4324/9780429499142-5.
127. Bauer, G. R. Incorporating intersectionality theory into population health research methodology: Challenges and the potential to advance health equity. *Soc. Sci. Med.* **110**, 10–17 (2014).
128. Hankivsky, O. *Intersectionality 101*. (The Institute for Intersectionality Research & Policy, SFU, 2014).
129. Rosenthal, L. & Lobel, M. Explaining racial disparities in adverse birth outcomes: Unique sources of stress for Black American women. *Soc. Sci. Med.* **72**, 977–983 (2011).
130. Lu, M. C. Childbirth Education Classes: Sociodemographic Disparities in Attendance and the Association of Attendance with Breastfeeding Initiation. *Matern. Child Health J.* **7**, 87–93 (2003).
131. Lu, M. C. *et al.* Closing the Black-White gap in birth outcomes: a life-course approach. *Ethn. Dis.* **20**, S2-62–76 (2010).
132. Secretary’s Advisory Committee for a National Strategy. Report of the Secretary’s Advisory Committee on Infant Mortality: Recommendations for Department of Health and Human Services Action and Framework for a National Strategy. www.hrsa.gov <https://www.hrsa.gov/sites/default/files/hrsa/advisory-committees/infant-mortality/reports/final-recommendations.pdf> (2013).

133. Martin, J. A. *et al.* Births: final data for 2005. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **56**, 1–103 (2007).
134. Thurston, H., Fields, B. E. & White, J. Does Increasing Access to Prenatal Care Reduce Racial Disparities in Birth Outcomes? *J. Pediatr. Nurs.* **59**, 96–102 (2021).
135. Institute of Medicine (US) Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. 10027 (National Academies Press, 2001). doi:10.17226/10027.
136. Declercq, E. R., Sakala, C., Corry, M. P., Applebaum, S. & Herrlich, A. Major Survey Findings of Listening to MothersSM III: Pregnancy and Birth: Report of the Third National U.S. Survey of Women’s Childbearing Experiences. *J. Perinat. Educ.* **23**, 9–16 (2014).
137. Peahl, A. F. & Howell, J. D. The evolution of prenatal care delivery guidelines in the United States. *Am. J. Obstet. Gynecol.* **224**, 339–347 (2021).
138. Walford, H. H., Trinh, S., Wiencrot, A. & Lu, M. C. What is the Role of Prenatal Care in Reducing Racial and Ethnic Disparities in Pregnancy Outcomes? in *Reducing Racial/Ethnic Disparities in Reproductive and Perinatal Outcomes* (eds. Handler, A., Kennelly, J. & Peacock, N.) 151–179 (Springer US, 2011). doi:10.1007/978-1-4419-1499-6_8.
139. Kogan, M. D., Kotelchuck, M., Alexander, G. R. & Johnson, W. E. Racial disparities in reported prenatal care advice from health care providers. *Am. J. Public Health* **84**, 82–88 (1994).
140. Nguyen, M. N., Siahpush, M., Grimm, B. L., Singh, G. K. & Tibbits, M. K. Women from racial or ethnic minority and low socioeconomic backgrounds receive more prenatal education: Results from the 2012 to 2014 Pregnancy Risk Assessment Monitoring System. *Birth* **46**, 157–165 (2019).
141. Wishart, D. *et al.* Racial and Ethnic Minority Pregnant Patients with Low-Income Experiences of Perinatal Care: A Scoping Review. *Health Equity* **5**, 554–568 (2021).
142. Novick, G. Women’s Experience of Prenatal Care: An Integrative Review. *J. Midwifery Womens Health* **54**, 226–237 (2009).
143. *Guidelines for perinatal care*. (American Academy of Pediatrics ; The American College of Obstetricians and Gynecologists, 2017).
144. Mazzoni, S. E. & Carter, E. B. Group prenatal care. *Am. J. Obstet. Gynecol.* **216**, 552–556 (2017).
145. Rising, S. Centering Pregnancy An Interdisciplinary Model of Empowerment. *J. Nurse. Midwifery* **43**, 46–54 (1998).

146. Schindler Rising, S., Kennedy, H. P. & Klima, C. S. Redesigning prenatal care through CenteringPregnancy. *J. Midwifery Womens Health* **49**, 398–404 (2004).
147. Centering Healthcare Institute. *CenteringPregnancy Facilitator's Guide*. (2017).
148. Gaudion, A. & Menka, Y. 'No decision about me without me': centering pregnancy. *Pract. Midwife* **13**, 15–18 (2010).
149. Teate, A., Leap, N. & Homer, C. S. E. Midwives' experiences of becoming CenteringPregnancy facilitators: A pilot study in Sydney, Australia. *Women Birth* **26**, e31–e36 (2013).
150. Andersson, E., Christensson, K. & Hildingsson, I. Mothers' satisfaction with group antenatal care versus individual antenatal care – A clinical trial. *Sex. Reprod. Healthc.* **4**, 113–120 (2013).
151. Benediktsson, I. *et al.* Comparing CenteringPregnancy® to standard prenatal care plus prenatal education. *BMC Pregnancy Childbirth* **13 Suppl 1**, S5 (2013).
152. Jafari, F., Eftekhar, H., Fotouhi, A., Mohammad, K. & Hantoushzadeh, S. Comparison of Maternal and Neonatal Outcomes of Group Versus Individual Prenatal Care: A New Experience in Iran. *Health Care Women Int.* **31**, 571–584 (2010).
153. Patil, C. L. *et al.* Randomized controlled pilot of a group antenatal care model and the sociodemographic factors associated with pregnancy-related empowerment in sub-Saharan Africa. *BMC Pregnancy Childbirth* **17**, 336 (2017).
154. Carter, E. B. *et al.* Pilot Randomized Controlled Trial of Diabetes Group Prenatal Care. *Am. J. Perinatol.* **39**, 045–053 (2022).
155. Mazzone, S. *et al.* The effect of group prenatal care for women with diabetes on social support and depressive symptoms: a pilot randomized trial. *J. Matern.-Fetal Neonatal Med. Off. J. Eur. Assoc. Perinat. Med. Fed. Asia Ocean. Perinat. Soc. Int. Soc. Perinat. Obstet.* **33**, 1505–1510 (2020).
156. Grenier, L. *et al.* Impact of group antenatal care (G-ANC) versus individual antenatal care (ANC) on quality of care, ANC attendance and facility-based delivery: A pragmatic cluster-randomized controlled trial in Kenya and Nigeria. *PLOS ONE* **14**, e0222177 (2019).
157. Centering Healthcare Institute. What We Do. <https://centeringhealthcare.org/what-we-do>.
158. CenteringPregnancy and CenteringParenting Annotated Bibliography. www.centeringhealthcare.org <https://www.centeringhealthcare.org/uploads/files/Centering-Healthcare-Institute-Annotated-Bibliography-2021.pdf>.

159. Catling, C. J. *et al.* Group versus conventional antenatal care for women. *Cochrane Database Syst. Rev.* **2017**, (2015).
160. Ickovics, J. R. *et al.* Group Prenatal Care and Perinatal Outcomes: A Randomized Controlled Trial. *Obstet. Gynecol.* **110**, 330–339 (2007).
161. Kennedy, H. P. *et al.* A Randomized Clinical Trial of Group Prenatal Care in Two Military Settings. *Mil. Med.* **176**, 1169–1177 (2011).
162. Liu, Y., Wang, Y., Wu, Y., Chen, X. & Bai, J. Effectiveness of the CenteringPregnancy program on maternal and birth outcomes: A systematic review and meta-analysis. *Int. J. Nurs. Stud.* **120**, 103981 (2021).
163. Ickovics, J. R. *et al.* Effects of group prenatal care on psychosocial risk in pregnancy: Results from a randomised controlled trial. *Psychol. Health* **26**, 235–250 (2011).
164. Ickovics, J. R. *et al.* Cluster Randomized Controlled Trial of Group Prenatal Care: Perinatal Outcomes Among Adolescents in New York City Health Centers. *Am. J. Public Health* **106**, 359–365 (2016).
165. Felder, J. N. *et al.* Depressive symptoms and gestational length among pregnant adolescents: Cluster randomized control trial of CenteringPregnancy® plus group prenatal care. *J. Consult. Clin. Psychol.* **85**, 574–584 (2017).
166. Tubay, A. T. *et al.* The Effects of Group Prenatal Care on Infant Birthweight and Maternal Well-Being: A Randomized Controlled Trial. *Mil. Med.* **184**, e440–e446 (2019).
167. Crockett, A. H. *et al.* Group versus traditional prenatal care for improving racial equity in preterm birth and low birthweight: the Cradle randomized clinical trial study [Manuscript submitted for publication]. (2022).
168. McKinnon, B. *et al.* Feasibility and preliminary effectiveness of group antenatal care in Senegalese health posts: a pilot implementation trial. *Health Policy Plan.* **35**, 587–599 (2020).
169. Patil, C. L. *et al.* Implementation challenges and outcomes of a randomized controlled pilot study of a group prenatal care model in Malawi and Tanzania. *Int. J. Gynecol. Obstet.* **139**, 290–296 (2017).
170. Liese, K. L. *et al.* Impact of group prenatal care on key prenatal services and educational topics in Malawi and Tanzania. *Int. J. Gynecol. Obstet.* **153**, 154–159 (2021).
171. Jeremiah, R. D. *et al.* A randomized group antenatal care pilot showed increased partner communication and partner HIV testing during pregnancy in Malawi and Tanzania. *BMC Pregnancy Childbirth* **21**, 790 (2021).

172. Sayinzoga, F. *et al.* Assessing the impact of group antenatal care on gestational length in Rwanda: A cluster-randomized trial. *PLOS ONE* **16**, e0246442 (2021).
173. Byerley, B. M. & Haas, D. M. A systematic overview of the literature regarding group prenatal care for high-risk pregnant women. *BMC Pregnancy Childbirth* **17**, 329 (2017).
174. Cunningham, S. D. *et al.* Group Prenatal Care Reduces Risk of Preterm Birth and Low Birth Weight: A Matched Cohort Study. *J. Womens Health* **28**, 17–22 (2019).
175. Crockett, A. H. *et al.* Effects of a Multi-site Expansion of Group Prenatal Care on Birth Outcomes. *Matern. Child Health J.* **23**, 1424–1433 (2019).
176. Lewis, J. B. *et al.* Group prenatal care and improved birth outcomes: Results from a type 1 hybrid effectiveness-implementation study. *Prev. Med.* **153**, 106853 (2021).
177. Heberlein, E. C., Smith, J. C., LaBoy, A., Britt, J. & Crockett, A. Birth Outcomes for Medically High-Risk Pregnancies: Comparing Group to Individual Prenatal Care. *Am. J. Perinatol.* a-1682-2704 (2021) doi:10.1055/a-1682-2704.
178. Dubay, L. *et al.* Improving Birth Outcomes And Lowering Costs For Women On Medicaid: Impacts Of ‘Strong Start For Mothers And Newborns’: An evaluation of the federal Strong Start for Mothers and Newborns program’s impact on birth outcomes and costs for Medicaid-covered women. *Health Aff. (Millwood)* **39**, 1042–1050 (2020).
179. Cunningham, S. D., Lewis, J. B., Thomas, J. L., Grilo, S. A. & Ickovics, J. R. Expect With Me: development and evaluation design for an innovative model of group prenatal care to improve perinatal outcomes. *BMC Pregnancy Childbirth* **17**, 147 (2017).
180. Carter, E. B. *et al.* Group Prenatal Care Compared With Traditional Prenatal Care: A Systematic Review and Meta-analysis. *Obstet. Gynecol.* **128**, 551–561 (2016).
181. Sheeder, J., Weber Yorga, K. & Kabir-Greher, K. A Review of Prenatal Group Care Literature: The Need for a Structured Theoretical Framework and Systematic Evaluation. *Matern. Child Health J.* **16**, 177–187 (2012).
182. Wadsworth, K. H. *et al.* Shared medical appointments and patient-centered experience: a mixed-methods systematic review. *BMC Fam. Pract.* **20**, 97 (2019).
183. Heberlein, E. C. *et al.* Qualitative Comparison of Women’s Perspectives on the Functions and Benefits of Group and Individual Prenatal Care. *J. Midwifery Womens Health* **61**, 224–234 (2016).
184. Hunter, L. J. *et al.* Better together: A qualitative exploration of women’s perceptions and experiences of group antenatal care. *Women Birth* **32**, 336–345 (2019).

185. McDonald, S. D., Sword, W., Eryuzlu, L. E. & Biringer, A. B. A qualitative descriptive study of the group prenatal care experience: perceptions of women with low-risk pregnancies and their midwives. *BMC Pregnancy Childbirth* **14**, 334 (2014).
186. McNeil, D. A. *et al.* Getting more than they realized they needed: a qualitative study of women's experience of group prenatal care. *BMC Pregnancy Childbirth* **12**, 17 (2012).
187. Risisky, D., Asghar, S. M., Chaffee, M. & DeGennaro, N. Women's Perceptions Using the CenteringPregnancy Model of Group Prenatal Care. *J. Perinat. Educ.* **22**, 136–144 (2013).
188. Teate, A., Leap, N., Rising, S. S. & Homer, C. S. E. Women's experiences of group antenatal care in Australia—the CenteringPregnancy Pilot Study. *Midwifery* **27**, 138–145 (2011).
189. Herrman, J. W., Rogers, S. & Ehrenthal, D. B. Women's Perceptions of CenteringPregnancy: A Focus Group Study. *MCN Am. J. Matern. Nurs.* **37**, 19–26 (2012).
190. Kennedy, H. P. *et al.* "I Wasn't Alone"—A Study of Group Prenatal Care in the Military. *J. Midwifery Womens Health* **54**, 176–183 (2009).
191. Hill, I., Cross-Barnet, C., Courtot, B., Benatar, S. & Thornburgh, S. What do women in Medicaid say about enhanced prenatal care? Findings from the national Strong Start evaluation. *Birth* **46**, 244–252 (2019).
192. Renbarger, K. M., Place, J. M. & Schreiner, M. The Influence of Four Constructs of Social Support on Pregnancy Experiences in Group Prenatal Care. *Womens Health Rep.* **2**, 154–162 (2021).
193. Hackley, B. *et al.* A Qualitative Study of Women's Recall of Content and Skills Developed in Group Prenatal and Well-Baby Care 2 Years Later. *J. Midwifery Womens Health* **64**, 209–216 (2019).
194. Dunkel Schetter, C. Psychological Science on Pregnancy: Stress Processes, Biopsychosocial Models, and Emerging Research Issues. *Annu. Rev. Psychol.* **62**, 531–558 (2011).
195. Lobel, M. *et al.* Pregnancy-specific stress, prenatal health behaviors, and birth outcomes. *Health Psychol.* **27**, 604–615 (2008).
196. Yim, I. S., Tanner Stapleton, L. R., Guardino, C. M., Hahn-Holbrook, J. & Dunkel Schetter, C. Biological and psychosocial predictors of postpartum depression: systematic review and call for integration. *Annu. Rev. Clin. Psychol.* **11**, 99–137 (2015).
197. Hetherington, E. *et al.* Preterm Birth and Social Support during Pregnancy: a Systematic Review and Meta-Analysis: Preterm birth and social support meta-analysis. *Paediatr. Perinat. Epidemiol.* **29**, 523–535 (2015).

198. Mitchell, A. M., Kowalsky, J. M., Christian, L. M., Belury, M. A. & Cole, R. M. Perceived social support predicts self-reported and objective health and health behaviors among pregnant women. *J. Behav. Med.* (2022) doi:10.1007/s10865-022-00306-5.
199. Nicoloro-SantaBarbara, J. *et al.* Patient-provider communication, maternal anxiety, and self-care in pregnancy. *Soc. Sci. Med.* **190**, 133–140 (2017).
200. Carter, E. B. & Mazzone, S. E. A paradigm shift to address racial inequities in perinatal healthcare. *Am. J. Obstet. Gynecol.* **224**, 359–361 (2021).
201. Picklesimer, A. H., Billings, D., Hale, N., Blackhurst, D. & Covington-Kolb, S. The effect of CenteringPregnancy group prenatal care on preterm birth in a low-income population. *Am. J. Obstet. Gynecol.* **206**, 415.e1-415.e7 (2012).
202. Heberlein, E. C. *et al.* The comparative effects of group prenatal care on psychosocial outcomes. *Arch. Womens Ment. Health* **19**, 259–269 (2016).
203. Novick, G., Womack, J. A. & Sadler, L. S. Beyond Implementation: Sustaining Group Prenatal Care and Group Well-Child Care. *J. Midwifery Womens Health* **65**, 512–519 (2020).
204. Phillippi, J. C. & Myers, C. R. Reasons Women in Appalachia Decline CenteringPregnancy Care. *J. Midwifery Womens Health* **58**, 516–522 (2013).
205. Pekkala, J. *et al.* Key Considerations for Implementing Group Prenatal Care: Lessons from 60 Practices. *J. Midwifery Womens Health* **65**, 208–215 (2020).
206. Weber Yorga, K. D. & Sheeder, J. L. Which Pregnant Adolescents Would be Interested in Group-Based Care, and Why? *J. Pediatr. Adolesc. Gynecol.* **28**, 508–515 (2015).
207. McDonald, S. D. *et al.* Why Are Half of Women Interested in Participating in Group Prenatal Care? *Matern. Child Health J.* **20**, 97–105 (2016).
208. Berman, R., Weber Yorga, K. & Sheeder, J. Intention to Participate in Group Prenatal Care: Moving Beyond Yes or No. *Health Promot. Pract.* **21**, 123–132 (2020).
209. Cunningham, S. D. *et al.* Group Prenatal Care Attendance: Determinants and Relationship with Care Satisfaction. *Matern. Child Health J.* **21**, 770–776 (2017).
210. Francis, E. *et al.* Group Prenatal Care Attendance and Women’s Characteristics Associated with Low Attendance: Results from Centering and Racial Disparities (CRADLE Study). *Matern. Child Health J.* **23**, 1371–1381 (2019).
211. Wagijo, M. R. *et al.* CenteringPregnancy in the Netherlands: Who engages, who doesn’t, and why. *Birth* **49**, 329–340 (2022).

212. Lagan, B. M., Sinclair, M. & George Kernohan, W. Internet Use in Pregnancy Informs Women's Decision Making: A Web-Based Survey. *Birth* **37**, 106–115 (2010).
213. Lagan, B. M., Sinclair, M. & Kernohan, W. G. What Is the Impact of the Internet on Decision-Making in Pregnancy? A Global Study. *Birth* **38**, 336–345 (2011).
214. Huberty, J., Dinkel, D., Beets, M. W. & Coleman, J. Describing the Use of the Internet for Health, Physical Activity, and Nutrition Information in Pregnant Women. *Matern. Child Health J.* **17**, 1363–1372 (2013).
215. Bjelke, M., Martinsson, A.-K., Lendahls, L. & Oscarsson, M. Using the Internet as a source of information during pregnancy — A descriptive cross-sectional study in Sweden. *Midwifery* **40**, 187–191 (2016).
216. Narasimhulu, D. M., Karakash, S., Weedon, J. & Minkoff, H. Patterns of Internet Use by Pregnant Women, and Reliability of Pregnancy-Related Searches. *Matern. Child Health J.* **20**, 2502–2509 (2016).
217. Prescott, J. & Mackie, L. “You Sort of Go Down a Rabbit Hole...You're Just Going to Keep on Searching”: A Qualitative Study of Searching Online for Pregnancy-Related Information During Pregnancy. *J. Med. Internet Res.* **19**, e194 (2017).
218. Bert, F. *et al.* Pregnancy e-health: a multicenter Italian cross-sectional study on internet use and decision-making among pregnant women. *J. Epidemiol. Community Health* **67**, 1013–1018 (2013).
219. Burleson, G., Naseem, M. & Toyama, K. An Exploration of African-American Pregnant Women's Information-Seeking Behavior in Detroit. in *Proceedings of the 2020 International Conference on Information and Communication Technologies and Development* 1–12 (ACM, 2020). doi:10.1145/3392561.3394647.
220. Sayakhot, P. & Carolan-Olah, M. Internet use by pregnant women seeking pregnancy-related information: a systematic review. *BMC Pregnancy Childbirth* **16**, 65 (2016).
221. Slomian, J., Bruyère, O., Reginster, J. Y. & Emonts, P. The internet as a source of information used by women after childbirth to meet their need for information: A web-based survey. *Midwifery* **48**, 46–52 (2017).
222. Farrant, K. & Heazell, A. E. P. Online information for women and their families regarding reduced fetal movements is of variable quality, readability and accountability. *Midwifery* **34**, 72–78 (2016).
223. Widarsson, M., Kerstis, B., Sundquist, K., Engström, G. & Sarkadi, A. Support Needs of Expectant Mothers and Fathers: A Qualitative Study. *J. Perinat. Educ.* **21**, 36–44 (2012).

224. Bender, J. L., Jimenez-Marroquin, M.-C. & Jadad, A. R. Seeking support on facebook: a content analysis of breast cancer groups. *J. Med. Internet Res.* **13**, e16 (2011).
225. Schoenebeck, S. The Secret Life of Online Moms: Anonymity and Disinhibition on YouBeMom.com. *Proc. Seventh Int. AAAI Conf. Weblogs Soc. Media* **7**, 555–562 (2013).
226. Lupton, D. The use and value of digital media for information about pregnancy and early motherhood: a focus group study. *BMC Pregnancy Childbirth* **16**, 171 (2016).
227. Golder, S., Ahmed, S., Norman, G. & Booth, A. Attitudes Toward the Ethics of Research Using Social Media: A Systematic Review. *J. Med. Internet Res.* **19**, e195 (2017).
228. Roberts, L. D. Ethical Issues in Conducting Qualitative Research in Online Communities. *Qual. Res. Psychol.* **12**, 314–325 (2015).
229. Fredriksen, E. H., Moland, K. M. & Sundby, J. “Listen to your body”. *Patient Educ. Couns.* **73**, 294–299 (2008).
230. Beyers-Carlson, E., Schoenebeck, S. & Volling, B. L. Mother of One to Mother of Two: A Textual Analysis of Second-Time Mothers’ Posts on the BabyCenter LLC Website. *Front. Psychol.* **13**, 859085 (2022).
231. Aston, M. *et al.* Second Opinions: Negotiating Agency in Online Mothering Forums. *Can. J. Nurs. Res.* **53**, 327–339 (2021).
232. Carlsson, T., Bergman, G., Karlsson, A.-M., Wadensten, B. & Mattsson, E. Experiences of termination of pregnancy for a fetal anomaly: A qualitative study of virtual community messages. *Midwifery* **41**, 54–60 (2016).
233. Moore, D., Ayers, S. & Drey, N. A Thematic Analysis of Stigma and Disclosure for Perinatal Depression on an Online Forum. *JMIR Ment. Health* **3**, e18 (2016).
234. Konheim-Kalkstein, Y. L., Whyte, R., Miron-Shatz, T. & Stellmack, M. A. What are VBAC Women Seeking and Sharing? A Content Analysis of Online Discussion Boards. *Birth* **42**, 277–282 (2015).
235. Petrovska, K., Sheehan, A. & Homer, C. S. E. The fact and the fiction: A prospective study of internet forum discussions on vaginal breech birth. *Women Birth* **30**, e96–e102 (2017).
236. Wexler, A. *et al.* Pregnancy and health in the age of the Internet: A content analysis of online “birth club” forums. *PLOS ONE* **15**, e0230947 (2020).
237. Rezaallah, B., Lewis, D. J., Pierce, C., Zeilhofer, H.-F. & Berg, B.-I. Social Media Surveillance of Multiple Sclerosis Medications Used During Pregnancy and Breastfeeding: Content Analysis. *J. Med. Internet Res.* **21**, e13003 (2019).

238. Gui, X., Chen, Y., Kou, Y., Pine, K. & Chen, Y. Investigating Support Seeking from Peers for Pregnancy in Online Health Communities. *Proc. ACM Hum.-Comput. Interact.* **1**, 1–19 (2017).
239. Ellis, L. & Roberts, L. Exploring the use and quality of Internet discussion forums in pregnancy: A qualitative analysis. *Birth* **47**, 153–161 (2020).
240. Chivers, B. R. *et al.* Perinatal Distress During COVID-19: Thematic Analysis of an Online Parenting Forum. *J. Med. Internet Res.* **22**, e22002 (2020).
241. Sherman, L. E. & Greenfield, P. M. Forging friendship, soliciting support: A mixed-method examination of message boards for pregnant teens and teen mothers. *Comput. Hum. Behav.* **29**, 75–85 (2013).
242. Blei, D. M., Ng, A. Y. & Jordan, M. I. Latent Dirichlet Allocation. *J. Mach. Learn. Res.* **3** 993–1022 (2003).
243. Chang, T. *et al.* Accelerating Mixed Methods Research With Natural Language Processing of Big Text Data. *J. Mix. Methods Res.* **15**, 398–412 (2021).
244. Chivers, B. R., Garad, R. M., Moran, L. J., Lim, S. & Harrison, C. L. Support Seeking in the Postpartum Period: Content Analysis of Posts in Web-Based Parenting Discussion Groups. *J. Med. Internet Res.* **23**, e26600 (2021).
245. Yamada, R., Rasmussen, K. & Felice, J. Mothers' Use of Social Media to Inform Their Practices for Pumping and Providing Pumped Human Milk to Their Infants. *Children* **3**, 22 (2016).
246. Yamada, R., Rasmussen, K. M. & Felice, J. P. "What Is 'Enough,' and How Do I Make It?": A Qualitative Examination of Questions Mothers Ask on Social Media About Pumping and Providing an Adequate Amount of Milk for Their Infants. *Breastfeed. Med.* **14**, 17–21 (2019).
247. Lebron, C. N., St. George, S. M., Eckembrecher, D. G. & Alvarez, L. M. "Am I doing this wrong?" Breastfeeding mothers' use of an online forum. *Matern. Child. Nutr.* **16**, (2020).
248. Ruthven, I., Buchanan, S. & Jardine, C. Relationships, environment, health and development: The information needs expressed online by young first-time mothers. *J. Assoc. Inf. Sci. Technol.* **69**, 985–995 (2018).
249. Ghouri, F., Hollywood, A. & Ryan, K. Urinary tract infections and antibiotic use in pregnancy - qualitative analysis of online forum content. *BMC Pregnancy Childbirth* **19**, 289 (2019).
250. Denton, L. K., Creeley, C. E., Stavola, B., Hall, K. & Foltz, B. D. An analysis of online pregnancy message boards: Mother-to-mother advice on medication use. *Women Birth* **33**, e48–e58 (2020).

251. Du, C. *et al.* “Beyond the Bump” – Insight Into the Postpartum Women’s Experience of Pelvic Organ Prolapse as Expressed on Reddit. *Urology* **150**, 99–102 (2021).
252. Liang, O. S., Chen, Y., Bennett, D. S. & Yang, C. C. Identifying Self-Management Support Needs for Pregnant Women With Opioid Misuse in Online Health Communities: Mixed Methods Analysis of Web Posts. *J. Med. Internet Res.* **23**, e18296 (2021).
253. Alang, S. M. & Fomotar, M. Postpartum Depression in an Online Community of Lesbian Mothers: Implications for Clinical Practice. *J. Gay Lesbian Ment. Health* **19**, 21–39 (2015).
254. Dalton, E. D. & Gruber, K. Being PAL: Uncertainty and Coping in r/PregnancyAfterLoss. *Health Commun.* **37**, 850–861 (2022).
255. Evans, M., Donelle, L. & Hume-Loveland, L. Social support and online postpartum depression discussion groups: A content analysis. *Patient Educ. Couns.* **87**, 405–410 (2012).
256. Kim, H.-S., Chung, M.-Y., Rhee, E. S. & Kim, Y. Is it reciprocating or self-serving?: Understanding coping strategies for postpartum depression in an online community for Korean mothers. *Health Care Women Int.* 1–18 (2022) doi:10.1080/07399332.2022.2037604.
257. Rouhi, M., Stirling, C. & Crisp, E. P. The ‘fallacy of normalcy’: A content analysis of women’s online post-childbirth health-related support. *Women Birth* **34**, e262–e270 (2021).
258. Baumer, E. P. S., Mimno, D., Guha, S., Quan, E. & Gay, G. K. Comparing grounded theory and topic modeling: Extreme divergence or unlikely convergence? *J. Assoc. Inf. Sci. Technol.* **68**, 1397–1410 (2017).
259. Andreotta, M. *et al.* Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behav. Res. Methods* **51**, 1766–1781 (2019).
260. Collins, J. W., David, R. J., Handler, A., Wall, S. & Andes, S. Very Low Birthweight in African American Infants: The Role of Maternal Exposure to Interpersonal Racial Discrimination. *Am. J. Public Health* **94**, 2132–2138 (2004).
261. Lespinasse, A. A., David, R. J., Collins, J. W., Handler, A. S. & Wall, S. N. Maternal support in the delivery room and birthweight among African-American women. *J. Natl. Med. Assoc.* **96**, 187–195 (2004).
262. Rankin, K. M., David, R. J. & Collins, J. W. African American women’s exposure to interpersonal racial discrimination in public settings and preterm birth: the effect of coping behaviors. *Ethn. Dis.* **21**, 370–376 (2011).
263. Dixon, B. *et al.* Maternal experiences of racial discrimination and child weight status in the first 3 years of life. *J. Dev. Orig. Health Dis.* **3**, 433–441 (2012).

264. Giurgescu, C., Zenk, S. N., Engeland, C. G., Garfield, L. & Templin, T. N. Racial Discrimination and Psychological Wellbeing of Pregnant Women. *MCN Am. J. Matern. Nurs.* **42**, 8–13 (2017).

265. Mahrer, N. E., Guardino, C. M., Hobel, C. & Dunkel Schetter, C. Maternal Stress Before Conception Is Associated with Shorter Gestation. *Ann. Behav. Med.* **55**, 242–252 (2021)

Tables and Figures

Table 2.1 Primary outcomes in studies of discrimination and perinatal health						
Author, Year	Neonatal Outcomes		Maternal Outcomes			
	PTB/GA	LBW/BW	Mental Health	Health Behaviors	Physical Disease	Stress Indicators
Shiono et al., 1997 ⁸⁸		X				
Collins et al., 2000 ²⁶⁰		X				
Rosenberg et al., 2002 ⁹⁵	X					
Dole et al., 2003 ⁹⁸	X					
Dole et al., 2004 ⁹⁹	X					
Mustillo et al., 2004 ⁹³	X	X				
Lespinasse et al., 2004 ²⁶¹		X				
Collins et al., 2004 ²⁶⁰		X				
Dominguez et al., 2008 ¹¹⁰		X				
Dailey et al., 2009 ¹⁰⁰		X				
Misra et al., 2010 ¹¹⁷	X					
Bennett et al., 2010 ¹⁰¹			X	X		
Rankin et al., 2011 ²⁶²	X					
Carty et al., 2011 ⁹⁴		X				
Dixon et al., 2012 ²⁶³		X				
Giurgescu et al., 2012 ¹¹³	X		X			
Ertel et al., 2012 ¹¹⁹			X			
Christian et al., 2012 ¹²²						X
Earnshaw et al., 2013 ¹⁰²		X				
Hilmert et al., 2014 ⁹⁷		X				
Slaughter-Acey et al., 2016 ¹¹⁶	X					
Giurgescu et al., 2016 ¹²¹						X
Francis et al., 2017 ¹⁰³				X		
Giurgescu et al., 2017 ²⁶⁴			X			
Gilliespie and Anderson, 2018 ¹¹⁴	X					X
Bower et al., 2018 ⁸⁹	X					
Grobman et al., 2018 ¹¹⁵	X	X			X	
Slaughter-Acey et al., 2019 ¹¹¹		X				
Daniels et al., 2020 ¹¹²	X					
Mahrer et al., 2021 ²⁶⁵	X					
Hackney et al., 2021 ⁹⁶	X	X	X			

Segre et al., 2021 ⁹⁰			X			
MacGregor et al., 2021 ¹⁰⁴					X	
Gillespie et al., 2021 ¹²⁰			X			X
Barber & Robinson, 2022 ⁹²	X	X				
Weeks et al., 2022 ⁹¹			X			
Abbreviations: PTB preterm birth, GA gestational age at birth, LBW low birth weight, BW birth weight						

Table 2.2 Studies investigating discrimination and gestational age at birth				
Author, Year	Design/Sample	Discrimination Measure	Outcome Variables	Findings
Rosenberg et al. 2002 ⁹⁵	Case control Black women who gave birth in the previous 2 years N=422 Cases N=4,544 Controls	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Preterm birth	Two of the nine items measuring racial discrimination were significantly associated with increased odds of preterm delivery. These items included report of unfair treatment on the job (OR1.3; 95% 1.1 to 1.6) and report that people acted afraid of them at least once a week (OR 1.4 ;95% CI 1.0 to 1.9).
Dole et al., 2003 ⁹⁸	Prospective cohort N=1,962 African American and White women, from two prenatal clinics in Central NC	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial and gender discrimination	Preterm birth	Experience of higher racial discrimination was associated with increased risk of preterm birth when compared to no experience of racial discrimination (RR 1.4; 95% CI 1.0 to 2.0). Experience of gender discrimination and risk of preterm birth neared but did not reach significance (RR 1.2; 95% CI 0.9 to 1.7).
Dole et al., 2004 ⁹⁹	Prospective cohort N=1,898 African American and White women, from two prenatal clinics in Central NC	Experiences of Discrimination Scale (EOD) measuring lifetime exposure to racial and gender discrimination, modified to discuss discrimination in getting medical care for this pregnancy	Preterm birth	Race stratified analysis determined, African American women who reported experiencing high levels of racial discrimination were at increased risk of preterm birth compared to those reporting no racial discrimination (RR 1.8; 95% CI 1.1 to 2.9). Experience of racial discrimination was not significantly associated with risk of preterm birth among white women in this sample. Experience of gender discrimination, was not significantly associated with risk of preterm birth in either racial group, though neared significance among American Women (RR 1.6; 95% CI 0.9 to 2.6).
Mustillo et al., 2004 ⁹³	Prospective cohort N=352 African American women, from Birmingham, AL, Chicago, IL,	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Preterm birth	Women reporting three or more experiences of racial discrimination were at higher risk of preterm delivery than those reporting no racial discrimination (OR 3.05; 95% CI 1.29 to 7.24).

	Oakland, CA and Minneapolis, MI			
Misra et al., 2010 ¹¹⁷	Hybrid retrospective and prospective cohort N=832 African American women, from Baltimore, MD	Racism and Lifetime Experiences Scale (RALES) measuring lifetime racial discrimination exposure Racism-Related Experiences (RRE) Scale measuring response to racism	Preterm birth	Lifetime and acute experiences of racial discrimination were not associated with increased risk of preterm birth in this sample. A three-way interaction was observed between lifetime experiences of racism, depressive symptoms during pregnancy and stress during pregnancy on risk of preterm birth. Lifetime racism scores above the median was associated with an increased risk of preterm birth in three subgroups moderated by depressive symptoms and stress.
Rankin et al., 2011 ²⁶²	Case control African American women, from Chicago, IL N=160 Cases N=117 Controls	Modified version of the Perceived Racism Scale (PRS) measuring lifetime and past year exposure to racial discrimination	Preterm birth	Women with high past year exposure to perceived racial discrimination were significantly more likely to have infants born preterm and low birth weight than those with low or moderate exposure (OR 2.5; 95% CI 1.2 to 5.2).
Giurgescu et al., 2012 ¹¹³	Cross-sectional N=72 African American women, from Chicago, IL	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Preterm birth	Experience of racial discrimination was not significantly associated with preterm birth in this sample.
Slaughter-Acey et al., 2016 ¹¹⁶	Retrospective cohort N=1,410 Black women, from Detroit, MI	Daily Life Experiences of Racism and Bother (DLE-B) measure of stressfulness of racial micro aggressions experienced during the past year	Preterm birth	Women who experienced moderate levels of daily racial discrimination were more likely to have a preterm birth than those who experienced low levels of daily racial discrimination (OR 1.67; 95% CI 1.16 to 2.40). Sub-analysis suggested this association differed by severity of depression symptoms.
Bower et al., 2018 ⁸⁹	Cross-sectional N=11,582 Non-Hispanic Black women, PRAMS respondents from 12 jurisdictions	Single item, feeling emotionally upset by racial discrimination in the year prior to delivery	Preterm birth	Women who felt upset by experiences of racial discrimination in the year prior to delivery were more likely to have a preterm birth than those who were not upset by experiences of racial discrimination (OR 1.29; 95% CI 1.04 to 1.59).
Gillespie and Anderson, 2018 ¹¹⁴	Prospective cohort N=91 African American women, from two midwestern prenatal clinics	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Gestational age at birth	Experience of racial discrimination was not associated with gestational age at birth in this sample.
Grobman et al., 2018 ¹¹⁵	Cross-sectional	Experience of Discrimination Scale (EOD) measuring	Preterm birth	Experience of racial discrimination was not associated with preterm birth in this sample.

	N=9,470 Nulliparous women, from eight clinical sites across the US	lifetime exposure to racial discrimination		
Daniels et al., 2020 ¹¹²	Cross-sectional N=173 African American women, from the San Francisco Bay area	Measurement of direct and vicarious racial discrimination at three time points: childhood, adolescence, adulthood Modified version of the Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination attributed to race, ethnicity, or skin color And measures adapted from Dominquez et al., 2008	Preterm birth	The association between discrimination and preterm birth varied by life stage and whether discrimination was direct or vicarious. Each unit increase in adolescent direct racial discrimination was associated with a 48% increase in odds of preterm birth (OR 1.48; 95% CI 1.00,2.19; p < 0.05) and each unit increase in childhood vicarious racial discrimination was associated with a 45% increase in odds of preterm birth (OR 1.45; 95% CI 1.01,2.09; p<0.05). Other discrimination variations (adult direct and vicarious, adolescent vicarious and childhood direct racial discrimination) were not associated with preterm birth in this sample.
Hackney et al., 2021 ⁹⁶	Prospecting cohort N= 199 women working full time	Workplace Prejudice/Discrimination Inventory adapted to focus on pregnancy discrimination	Gestational age at birth	Perceived pregnancy discrimination in the workplace was indirectly associated with lower gestational age at delivery through maternal stress (B=-.19, p=.02).
Mahrer et al., 2021 ²⁶⁵	Prospective cohort N=360 Women, from Washington, DC, Baltimore, MD, Los Angeles Country, CA, Lake Country, IL and seven counties in eastern NC	Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination	Length of gestation	Latent stress factors of stress appraisals and stressors the later including discrimination experiences were associated with shorter gestation length (Stress appraisals: B=-.19; p<.01; Stressors: B=-.59; p<.01).
Barber and Robinson, 2022 ⁹²	Cross-sectional N=2,634 women, PRAMS respondents from Virginia	two items, experience of racial discrimination and being emotionally upset by racial discrimination in the year prior to delivery	Preterm birth	In race stratified analysis, racial discrimination was not significantly associated with likelihood of preterm birth among non-Hispanic white women and women of other races. However, among non-Hispanic black women, those reporting racial discrimination had greater risk of preterm birth (OR 7.18; 95% CI 2.28 to 22.65).

Table 2.3 Studies investigating discrimination and infant birth weight or size				
Author, Year	Design/Sample	Discrimination Measure	Outcome Variables	Findings
Shiono et al., 1997 ⁸⁸	Cross-sectional N=1150 Women, from Chicago, IL and New York City	Experience of one or more incidents of racial discrimination during pregnancy	Birthweight	Experience of racial discrimination during pregnancy was not associated with birthweight in this sample.
Collins et al., 2000 ¹¹⁸	Case control African American women, from Chicago, IL N=25 Cases N=60 Control	Modified Experiences of Discrimination (EOD) Scale measuring lifetime exposure to racial discrimination during pregnancy	Very low birthweight	In the overall sample, experience of racial discrimination during pregnancy was not associated with risk of very low birthweight. However, among women with two or more risk factors (high parity, late/no prenatal care, inadequate social support, cigarette smoker, alcohol or illicit drug use) experience of racial discrimination during pregnancy was associated with increased likelihood of very low birthweight (OR 4.4; 95% CI 1.1 to 18).
Collins et al., 2004 ²⁶⁰	Case control African American women, from Chicago, IL N=104 Cases N=208 Controls	Modified Experiences of Discrimination (EOD) Scale measuring lifetime and pregnancy exposure to racial discrimination Perceived Racism Scale (PRS) measuring lifetime and past years' experience of racial discrimination at place of employment	Very low birthweight	The odds of delivering a very low birthweight infant increased with lifetime exposure to racial discrimination in a single domain (OR 1.9; 95% CI 1.2 to 3.1), as well as three or more domains (OR 3.2; 95% CI 1.5 to 6.6) suggesting a dose response relationship.
Lespinasse et al., 2004 ²⁶¹	Case control African American women, from Chicago, IL N=104 Cases N=208 Controls	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Very low birthweight	Women who reported racial discrimination in one or more domains and three or more domains were more likely to give birth to a very low birthweight infant compared to women who reported no discrimination (one or more: OR 1.9; 95% CI 1.2 to 3.0; p<.05, three or more: OR 2.7; 95% CI 1.3 to 5.4; p<.05).
Mustillo et al., 2004 ⁹³	Prospective cohort N=352 African American Women, from Birmingham, AL, Chicago,	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Low birthweight	Women reporting three or more experiences of racial discrimination were at higher risk of low birthweight than those reporting no discrimination (OR 4.95; 95% CI 1.43 to 17.39).

	IL, Oakland, CA and Minneapolis, MI			
Dailey et al., 2009 ¹⁰⁰	Prospective cohort N=108 African American women, from Northern California	Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination	Birthweight	Discrimination due to maternal age and physical disability were significant predictors of birthweight (age: B .18, p=.04; physical disability: B -.26, p<.001).
Dominquez et al., 2008 ¹¹⁰	Prospective cohort N=124 African American and non-Hispanic White women, from Los Angeles County, CA	Modified Experiences of Discrimination (EOD) Scale measuring lifetime exposure to racial discrimination Four separate sets of questions, whether they or someone close to them (direct or vicarious) experienced discrimination because of their race in childhood or adulthood	Birthweight adjusting for gestational age at delivery	Each unit increase in perceived racism across the lifetime was associated with a 39.6 gram decrease in birthweight (B=10.17; p<.05). Perceived racism vicariously experienced as a child was associated with decreased birth weight (B=-.25; p<.01). In racially stratified analysis, lifetime perceived racism (B=-.28; p<.05) and childhood-vicarious perceived racism (B=-.26; p<.05) predicted significant additional variance in birthweight in infants of African American women but not in those of non-Hispanic White women. Lifetime perceived racism and childhood vicarious racism mediated the relationship between race and infant birthweight.
Carty et al., 2011 ⁹⁴	Cross-sectional N=629 African American and White women, from urban areas of Genesee and Saginaw Counties, MI	Modified Everyday discrimination Scale (EDS) measuring frequency of racial discrimination in the past year Measurement of group-impact racism and racism related stress adapted from the Racism and Life Experiences Scale (RALES) Racism-Related Experiences (RRE) Scale measuring response to racism	Low birthweight	The association between emotional responses to racism related experiences and low birthweight neared but did not reach significance (OR 1.17; 95% CI 0.93 to 1.48).
Dixon et al., 2012 ²⁶³	Prospective cohort N=539 racial and ethnic	Experiences of Discrimination (EOD) Scale measuring lifetime exposure to racial discrimination	Birthweight for gestational age	Mothers who reported three or more domains of racial discrimination gave birth to infants of lower birthweight than those reporting no

	minority women, from eastern Massachusetts			racial discrimination (B -0.25; 95% CI -0.45 to -0.45).
Earnshaw et al., 2013 ¹⁰²	Prospective cohort N=420 Black and Latina women, from New York City	Modified Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination	Low birthweight	Women who experienced discrimination were more likely to have a low birthweight infant than those who did not experience discrimination (OR 2.78; p=0.5). Depressive symptoms mediated this relationship (B=1.04; p<.01), such that everyday discrimination was associated with increased depressive symptoms and depressive symptoms were associated with giving birth to a low birthweight infant.
Hilmert et al., 2014 ⁹⁷	Prospective cohort N=39 African American women, from Los Angeles and Orange County, CA	Modified Experiences of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination Subscales for direct and indirect racial discrimination exposure in childhood and adulthood	Birthweight adjusting for gestational age at delivery	The association between experience of overall racial discrimination and birthweight neared but did not reach significance (B=-.27, p<.10). Experience of personal racial discrimination in adulthood was associated with reduced birthweight (B=-.26; p<.05). The racism by change in maternal systolic blood pressure interaction was significant for childhood indirect (B=-.25; p<.05) and neared significance for childhood personal racism (B=-.22; p=.10).
Grobman et al., 2018 ¹¹⁵	Cross-sectional N=9,470 Nulliparous women, from eight clinical sites across the US	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Small for gestational age	Perceived discrimination was not significantly associated with small for gestational age birth.
Slaughter-Acey et al., 2019 ¹¹¹	Hybrid retrospective and prospective cohort N=778 African American women, from Baltimore City, MD	Racism and Lifetime Experiences Scale (RALES) measuring frequency of racial discrimination (direct, vicarious, and collective) and racism-related stress	Small for gestational age	Experience of racism was not associated with odds of small for gestational age in the overall sample. In age stratified analysis, overall experience of racism and experience of group racism were associated with higher odds of small for gestational age among women aged 25 or older (overall: OR 1.45; 95% CI 1.02 to 2.08, group: OR 2.84; 95% CI 1.10-7.32). Overall experience of racism and experience of group racism were not significantly associated with small for gestational age among women 18 or younger or 19-24.

Hackney et al., 2021 ⁹⁶	Prospective cohort N=199 women working full time	Workplace Prejudice/Discrimination Inventory adapted to focus on pregnancy discrimination	Birthweight	Perceived pregnancy discrimination in the workplace was indirectly associated with lower birthweight through maternal stress (B=-.19, p<.01).
Barber and Robinson, 2022 ⁹²	Cross-sectional N=2,634 women, PRAMS respondents from Virginia	2 items, experience of racial discrimination and being emotionally upset by racial discrimination in the year prior to delivery	Low birthweight, Small for gestational age	Racial discrimination was associated with greater likelihood of low birthweight (OR 2.27; 95% CA 1.18 to 4.38). In race stratified analysis, racial discrimination was not significantly associated with low birthweight among non-Hispanic white women and women of other races. However, among non-Hispanic black women, those reporting racial discrimination were more likely to deliver a low birthweight infant (OR 3.56; 95% CI 1.28 to 9.91).

Table 2.4 Studies investigating discrimination and maternal health outcomes					
Outcome Category	Author, Year	Design/ Sample	Discrimination Measure	Outcome Variables	Findings
Mental health & Health behaviors	Bennett et al., 2010 ¹⁰¹	Cross-sectional N=4,454 women, from Philadelphia, PA	Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination Modified Scale of Major Discrimination measuring discrimination in hiring and policing	Perinatal depressive symptoms, Smoking during pregnancy, Alcohol use	Only everyday discrimination remained significantly associated with outcomes following adjustment. Women with high levels of perceived everyday discrimination were more likely than women with no or little discrimination to have depressive symptoms (PR=1.82; 95% CI 1.49, 2.21). Everyday discrimination was associated with smoking during pregnancy (PR 1.41, 95% CI 1.15-1.74) and recent alcohol use (PR 1.23, 95% CI 1.12-1.36).
Mental health	Ertel et al., 2012 ¹¹⁹	Prospective cohort Non-Hispanic Black women, 2 cohorts drawn from eight obstetrical practices in the	Modified Experiences of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Depressive symptoms	Experiences of racial discrimination were associated with increased odds of depression symptoms among women recruited from public clinics (OR 1.48; 95% CI 1.24, 1.76). Among women recruited from private practices, experiences of racial discrimination were

		greater Boston area, MA Public clinics n=532 Private practices n=352			not significantly associated with increased odds of depression symptoms (OR 1.13; 95% CI 0.93,1.38).
Mental health	Giurgescu et al., 2012 ¹¹³	Cross-sectional N=72 African American women, from the postpartum unit of a medical center in Chicago, IL	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Psychological general wellbeing	Experiences of racial discrimination did not predict psychological wellbeing in this sample.
Stress indicators	Christian et al., 2012 ¹²²	Prospective cohort N=56 Black and white women, Ohio State University Medical Center	Experiences of Discrimination (EOD) Scale measuring lifetime exposure to racial discrimination	Epstein-Barr virus reactivity in pregnancy and postpartum	Black women who reported high discrimination showed higher EBQ VCA IgG antibody titers than Black women who reported low discrimination in the first trimester p=0.04) and then white women at all time points (p<0.001).
Stress indicators	Giurgescu et al., 2016 ¹²¹	Cross-sectional N=96 African American women, from a midwifery practice of a medical center in Chicago, IL	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Systematic inflammation	Maternal experiences of racial discrimination were associated with higher systematic inflammation in the form of higher cytokine levels of IL-4 (B=2.16, 95% CI 1.02, 3.30, p<.001) and IL-6 (B=1.86, 95% CI 0.61, 3.11, p<.05).
Mental health	Giurgescu et al., 2017 ²⁶⁴	Cross-sectional N=107 African American women, from a university-based nurse midwifery practice	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Psychological general wellbeing	Experiences or racial discrimination were negatively associated with psychological wellbeing (b=-1.96,95% CI -3.80 to -.21; p=.031).
Health behaviors	Francis et al., 2017 ¹⁰³	Prospective cohort N=640 Women, from a hospital and University in Ohio	Everyday Discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination,	Perinatal sleep quality	Everyday experiences of racial discrimination were associated with poorer overall sleep quality (B=.08; 95% CI .03 to .13; p<.05) but was not significantly associated change in sleep quality overtime. In race

			examined discrimination attributed to race only		stratified analysis, sleep quality (B=.02; 95% CI .01 to .03; p<.05) and sleep duration (b=.02; 95% CI .01 to .04; p<.05) were associated with everyday racial discrimination among White women but not Black women. Alternatively, daytime dysfunction (b=.01; 95% CI .002 to 0.2; p<.05) and sleep latency (B=.01; 95% .002 to 0.3; p<.05) were associated with everyday racial discrimination among Black women but not among White women.
Stress indicators	Gillespie and Anderson, 2018 ¹¹⁴	Prospective cohort N=91 African American women, from two midwestern prenatal clinics	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Maternal cortisol levels and leukocyte glucocorticoid sensitivity	There was no main effect of racial discrimination on maternal cortisol levels. However, a significant discrimination by response interaction was observed, such that experiencing moderate discrimination was associated with greater maternal cortisol levels than no discrimination among women reporting internalizing responses (b=0.68; p=0.001). Racial discrimination was negatively associated with leukocyte glucocorticoid sensitivity.
Physical disease	Grobman et al., 2018 ¹¹⁵	Cross-sectional N=9,470 Nulliparous women, from eight clinical sites across the US	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Hypertensive disease of pregnancy	Perceived discrimination was not significantly associated with hypertensive disease of pregnancy in this sample.
Mental health	Segre et al., 2020 ⁹⁰	Cross-sectional N=2,805 Women, Pregnancy Risk Assessment Monitoring System (PRAMS)	Single item, feeling emotionally upset by racial discrimination in the year prior to delivery	Postpartum depression	Women emotionally upset by racial discrimination in the year prior to their baby being born were more likely to experience depressed moods postpartum than those not emotionally upset by racial discrimination (OR 2.15; 95% CI 1.07-4.31).

		postnatal survey respondents from Iowa			
Mental health	Hackney et al., 2021 ⁹⁶	Prospective cohort N=199 pregnant persons working full time, Amazon Mechanical Turk (MTurk), online pregnancy forums and social media sites	Workplace Prejudice/Discrimination Inventory adapted to focus on pregnancy discrimination	Perceived stress, Postpartum depressive symptoms	Perceived pregnancy discrimination in the workplace was associated with increased stress (B=.31; p<.001). Maternal stress was associated with increased postpartum depressive symptoms (B=.53; p<.001). Perceived pregnancy discrimination in the workplace was indirectly associated with increased levels of postpartum depressive symptoms through maternal stress (B=.53, p<.01).
Mental health & Stress indicators	Gillespie et al., 2021 ¹²⁰	Prospective cohort N=93 Non-Hispanic Black women, Ohio State University	Experience of Discrimination Scale (EOD) measuring lifetime exposure to racial discrimination	Systematic inflammation, prenatal perceived stress, depressive symptoms	Associations between racial discrimination and inflammation varied by rating of total life course stress (p=0.034). When total life stress was low, moderate discrimination was associated with the highest systematic inflammation levels. Greater racial discrimination was associated with higher prenatal perceived stress (t=2.43; p=.017) but not prenatal depressive symptoms.
Physical disease	MacGregor et al., 2021 ¹⁰⁴	Prospective cohort N=595 Women without pregestational diabetes, from four sites: Chicago, IL, Schuylkill County, PA, Pittsburgh, PA and San Antonio TX	Everyday discrimination Scale (EDS) measuring the frequency and source of chronic experiences of discrimination	Incidence of gestational diabetes mellitus	Women scoring in the top discrimination quartile were significantly more likely to develop gestational diabetes mellitus than those with lower scores (12.8% vs. 7.0%; OR 2.11; 95% CI 1.03 to 4.22). Obesity was found to mediate 22.6% of this relationship between discrimination and gestational diabetes mellitus.
Mental health	Weeks et al., 2022 ⁹¹	Cross-sectional N=18,785 Women of	Single item, feeling emotionally upset by racial discrimination in the	Postpartum depression	Being upset by recent racial discrimination was associated with higher odds of postpartum depression (OR 2.7; 95% CI 2.2 to 3.4).

		color (Hispanic, non-Hispanic Black and non-Hispanic “other” race), Pregnancy Risk Assessment Monitoring System (PRAMS) postnatal survey respondents from nine jurisdictions	year prior to delivery		In race stratified analysis, the relationship remained significant in all races but was strongest for non-Hispanic Black women (Hispanic OR 2.2; 95% CI 1.4 to 3.4, women of other races: OR; 2.2; 95% CI 1.5 to 3.3, non-Hispanic Black: OR 3.5; 95% CI 2.6 to 4.8).
--	--	--	------------------------	--	---

Table 2.5 Primary outcomes examined in randomized controlled trials of group prenatal care

Region	Author(s)	Neonatal			Maternal		Care		Other
		PTB	LBW	NICU	MDD/PPD	BF	Adeq.	Sat.	
US	Ickovics et al., 2007 ¹⁶⁰	X	X			X	X	X	
	Ickovics et al., 2011 ¹⁶³				X				
	Ickovics et al., 2016 ¹⁶⁴	X	X	X		X			
	Felder et al., 2017 ¹⁶⁵				X				
	Kennedy et al., 2011 ¹⁹⁰	X	X	X	X		X	X	
	Tubay et al., 2019 ¹⁶⁶		X		X			X	
	Crocket et al., 2022 ¹⁶⁷	X	X						
	Mazzoni et al., 2020 ¹⁵⁵				X				Diabetes support
	Carter et al., 2022 ¹⁵⁴	X	X	X		X	X	X	Diabetes management
Iran	Jafari et al., 2010 ¹⁵²	X	X			X			
Sweden	Andersson et al., 2013 ¹⁵⁰						X	X	
Africa	Grenier et al., 2019 ¹⁵⁶						X		
	Mckinnon et al., 2020 ¹⁶⁸		X		X	X	X		
	Patil et al., 2017 ¹⁵³					X	X	X	HIV knowledge
	Patil et al., 2017 ¹⁶⁹								Pregnancy empowerment
	Liese et al., 2021 ¹⁷⁰						X		

	Jeremiah et al., 2021 ¹⁷¹								HIV partner communication
	Sayinzoga et al., 2021 ¹⁷²	X					X		
Abbreviations: US, United States; PTB, preterm birth; LBW low birthweight; NICU, neonatal intensive care unit; MDD, major depressive disorder; PPD, postpartum depression; BF, breast feeding; Adeq, adequacy; Sat, satisfaction									

Table 2.6 Characteristics of randomized control trials of group prenatal care in the US					
Author(s), Year	Design & Study Years	Participant Characteristics, N & Setting	Intervention & Control	Outcomes	Findings
Ickovics et al., 2007 ¹⁶⁰	RCT 2001-2004	Young women (14-25) Medically low risk n=1,047 Two publicly funded university-affiliated hospital prenatal clinics in New Haven, CT and Atlanta, GA	CenteringPregnancy (CP) and CenteringPregnancy Plus (CP+) Standard individual care	Preterm birth, low birth weight, cost of care, adequacy of prenatal care, Apgar score at 5 minutes, breastfeeding initiation, pregnancy knowledge, prenatal distress, preparedness for delivery and infant care, satisfaction with prenatal care	GPNC patients were significantly less likely to deliver preterm (13.8% vs. 9.8%; OR 0.67; 95% CI 0.44 to 0.99; p=.045). These effects were stronger when examined in African American women (15.8% vs. 10.0%; OR 0.59; 95% CI 0.38 to 0.92; p=.02). GPNC patients were less likely to have suboptimal prenatal care (p<.01), were more satisfied with care (p<.001), had greater prenatal knowledge (p<.001) and had higher breastfeeding initiation (66.5% vs. 54.6%, p<.001).
Ickovics et al., 2011 ¹⁶³	RCT 2001-2004	Young women (14-25) Medically low risk n=1,047 Two publicly funded university-affiliated hospital prenatal clinics in New Haven, CT and Atlanta, GA	CenteringPregnancy Plus (CP+) Standard individual care	Stress, self-esteem, social support, social conflict, depressive symptoms,	No difference in psychosocial function between GPNC and IPNC patients in the overall sample. However, among patients in the top tertial of stress early in pregnancy (n=388), CP+ patients reported significantly higher self-esteem (t=-2.64; p=0.009), lower stress (t=2.84; p=0.005) and lower social conflict (t=2.68; p=0.008) in the third trimester of pregnancy. Among patients in the top tertial of stress, CP+ patients reported lower social conflict (t=2.89; p=0.004) and depressive symptoms (t=2.32; p=0.02) at one year postpartum.

Ickovics et al., 2016 ¹⁶⁴	Cluster RCT 2008-2012	Young women (21-14) Medically low risk n=1148 14 health centers in New York City	CenteringPregnancy Plus (CP+) Traditional individual prenatal care	Preterm birth, low birth weight, small for gestational age, Admission to NICU, Days in NICU, breastfeeding initiation, STI postpartum, rapid repeat pregnancy, unprotected sexual intercourse postpartum	In intention-to-treat analysis, GPNC patients were less likely to deliver a small for gestational age infant (11.0% vs. 15.8%; OR=0.66; 95% CI 0.44 to 0.99). In as-treated analysis, the greater the number of GPNC sessions patients attended, controlling for the number of IPNC visits attended, the lower patients odds of delivering a small for gestational age (OR 0.91; 95% CI 0.85 to 0.99), preterm (OR 0.76; 95% CI 0.69-0.84) or low birth weight infant (OR 0.81; 95% CI 0.73-0.89).
Felder et al., 2017 ¹⁶⁵	Cluster RCT 2008-2012	Young women (14-21) Medically low risk n=1135 14 health centers in New York City	Group prenatal care (CenteringPregnancy Plus) Individual prenatal care	Depressive symptoms	GPNC patients experienced greater reduction in perinatal depressive symptoms from baseline to postpartum (p=.003).
Kennedy et al., 2011 ¹⁹⁰	RCT 2005-2007	Military Medically low risk n=322 Prenatal care clinics at a Naval Hospital in the Pacific Northwest and a US Air Force Medical Group on the Atlantic coast	Group prenatal care (CenteringPregnancy) Individual prenatal care	Adequacy of prenatal care, prenatal health behaviors, self-efficacy in childbirth, maternal weight gain, gestational age at birth, use of analgesia, labor, induction/augmentation, mode of delivery, birth weight, Apgar score, NICU admissions, missed workdays, social support, care satisfaction, stress, prenatal distress, perinatal depressive	GPNC patients were more likely to receive adequate prenatal care (p<.0005) and were more likely to be satisfied with their care (p<.001).

				symptoms, postpartum depression)	
Tubay et al., 2019 ¹⁶⁶	RCT 2012-2014	Military >18yo Medically low risk n=129 Medical treatment facility in Northern California	Group prenatal care (CenteringPregnancy) Traditional one-on-one prenatal care	Infant birthweight appropriateness for gestational age, Maternal anxiety, depression, patient satisfaction	GPNC patients were more likely to deliver infants of appropriate birth weight for gestational age rather than small or large for gestational age (OR 1.12; 95% CI .01. 1.25; p=0.04). Overall satisfaction with care was similar between care arms. However, GPNC patients were more likely to be satisfied with the “accessibility and convenience” of care (p=.048).
Crocket et al., 2022 ¹⁶⁷	RCT 2016-2020	14-45yo Medically low risk n=2350 Hospital affiliated prenatal care clinic in SC	Group prenatal care (CenteringPregnancy) Individual prenatal care	Preterm birth and low birth weight	No significant difference in preterm birth or low birth weight. No prenatal care by race and ethnicity interaction was observed for preterm birth or low birth weight, though analysis was underpowered for comparison due to shortened recruitment and lower than estimated rates of adverse birth outcomes among the study population.
Mazzoni et al., 2020 ¹⁵⁵	pilot RCT 2015-2017	type 2 or gestational diabetes diagnosis n=84 Two sites: Washington University Medical Center (WUMC) and Denver Health Medical Center (DHMC)	Diabetes group prenatal care Individual prenatal care in the diabetes clinic	Diabetes support and postpartum depression symptoms	GPNC patients reported greater composite diabetes specific positive peer support than those assigned to individual prenatal care (52.5 vs. 26.3%; p<.02) but showed no difference in depressive symptoms.
Carter et al., 2022 ¹⁵⁴	pilot RCT 2015-2017	type 2 or gestational diabetes diagnosis n=84 Two sites: Washington	Diabetes group prenatal care Individual prenatal care in the diabetes clinic	Completion of diabetes self-care activities: antenatal care outcomes, maternal outcomes, neonatal	GPNC patients were more likely to report eating the recommended servings of fruits/vegetables a day (p>.01). Antenatal care, maternal and neonatal outcomes were similar

		University Medical Center (WUMC) and Denver Health Medical Center (DHMC)		outcomes, diabetes management outcomes	between care arms, except GPNC patients gained less weight per week during the study period (0.2 vs. 0.5 lbs. per week; p=.03). GPNC patients diagnosed with gestational diabetes were more likely to have postpartum glucose tolerance testing (70 vs. 21%; p=0.02).
--	--	--	--	--	---

Table 2.7 Characteristics of randomized control trials of group prenatal care outside the US

Author(s), year	Country	Design & Study Years	Participant Characteristics, N & setting	Control & Intervention	Outcomes	Findings
Jafari et al., 2010 ¹⁵²	Zanjan, Iran	Cluster RCT 2007-2009	Medically low risk N=628 14 health centers	Group prenatal care Routine individual prenatal care (traditional western model)	Infant birth weight, low birth weight, preterm birth, intrauterine growth restriction, perinatal death, Apgar score, infant hospital admission, multivitamin use, iron supplement use, mode of delivery, breastfeeding, diagnosis of urinary tract infection, diagnosis of vaginal infection, premature rupture of membranes, and pregnancy related hypertension	GPNC patients had greater birth weight (mean difference 87.7; 95% CI 20.7 to 154.7, p<.011). Likelihood of cesarean delivery was significantly reduced in the GPNC model (OR 0.71; 95% CI 0.55 to 0.89; p=.031). GPNC patients were more likely to take multivitamins (OR 3.28; 95% CI 2.40 to 4.49; p=.001) and iron supplements during pregnancy (OR 2.84; 95% CI 1.98, 4.09; p=.001) and to use contraception postpartum (OR 1.83; 95% CI 1.12 to 2.89; p=.013). GPNC patients breastfeed (OR 2.73; 95% CI 1.98 to 4.89; p=.001) and breastfeed exclusively (OR 2.61; 95% CI 2.17 to 3.12; p=.001) at higher rates.
Andersson et al., 2013 ¹⁵⁰	Sweden	Cluster RCT	Speak Swedish N=700	Group-based antenatal care (comparable to	Number of visits to midwife, number of	Women in both care arms reported care as deficient in more than half the areas

		2008-2011	31 midwives from 12 prenatal clinics	CenteringPreg nancy) Standard care	visits to physician, other antenatal activities (ex. yoga, aqua aerobics etc.), satisfaction with activities, care support contact with other parents, prenatal care help initiate for breastfeeding, overall satisfaction	measured. No overall difference in care satisfaction was found. However, when items were analyzed individually, variables that differed favored group prenatal care. GPNC patients reported higher satisfaction with support of contact with other parents (OR 3.86; 95% CI 2.30 to 6.46; p<.0001) and with initiation of breastfeeding (OR 1.75; 95% CI 1.02 to 2.88; p=.04) compared to IPNC patients.
Grenier et al., 2019 ¹⁵⁶	Nigeria and Kenya	Cluster RCT 2016-2018	>15yo Nigeria N=1018 Kenya N=826 20 facilities per country	Group antenatal care (CenteringPreg nancy adapted to include 5 monthly 2hr sessions) Individual antenatal care (Four-visit focused antenatal model)	Proportion of women reporting facility-based delivery, completion of birth planning and complication readiness actions, prenatal care attendance, postnatal care attendance and timing, quality of prenatal care	In Nigeria, GPNC patients were more likely to have a facility-based delivery (OR 2.30; 95% CI 1.51 to 3.49). GPNC patients in both countries were more likely to attend 4 or more prenatal care visits (Nigeria OR 13.30; 95% CI 7.69 to 22.99; p<0.001 and Kenya OR 7.12; 95% CI 3.91, 12.97; p<0.001), to complete all birth planning and complication planning actions (Nigeria OR 4.49; 95% CI 1.52 to 13.32; p<.001 and Kenya OR 2.86; 95% CI 1.11 to 7.38; p=.030) and to receive higher quality of care (Nigeria OR 5.8; 95% CI 1.98 to 17.21; p<.001; Kenya OR 5.08; 95% CI 2.31 to 11.16;

						p<.001). In Kenya, GPNC patients were more likely to attended at least one postnatal care visit (OR 2.84; 95% CI 1.37 to 5.90; p=.005).
Mckinnon et al., 2020 ¹⁶⁸	Kaolack district, Senegal	Pilot RCT 2017-2019	>15yo N=330 6 health posts	Group antenatal care (model adapted from Grenier et al., 2019) Traditional antenatal care (four visit focused antenatal care model)	Prenatal care visit attendance, delivering in a health facility, self-efficacy score, postnatal depression score infant, postnatal care visit attendance, exclusive breastfeeding, complete vaccination at birth, low birth weight, perinatal death	GPNC patients were more likely to have received four or more prenatal care visits (RR 1.26; 95% CI 1.08 to 1.45) maternal self-efficacy (RR 1.07; 95% CI 1.03 to 1.11) and exclusive breastfeeding (RR 1.23; 95% CI 1.08 to 1.38).
Patil et al., 2017 ¹⁵³	Malawi and Tanzania	Pilot RCT 2014-2015	>15yo Malawi N=91 Tanzania N=102 Two rural clinics in central Malawi and one urban clinic in Dar es Salaam, Tanzania	Group antenatal care plus (adapted CenteringPregnancy Plus) Standard individual antenatal care (four-visit focused antenatal model, six-week postpartum visit)	Prenatal care attendance (at least four visits), attendance at 6-week postnatal visit, satisfaction, mental distress, exclusive breastfeeding postpartum, HIV knowledge (knowledge of HIV prevention of mother-to-child transmission (PMTCT)	GPNC patients were more likely to attend all four prenatal care visits (OR 10.68; 95% CI 4.34-26.29; p<.001) and to attend a 6-week postnatal visit (OR 2.89; 95% CI 1.57-5.29; p<.001). GPNC patients had significantly higher satisfaction with care, higher pregnancy related empowerment scores (difference 8.01; 95% CI 6.00 to 10.04; p<.001) and lower mental distress scores (difference 11.56; 95% CI 9.65 to 13.47; p<.001). GPNC patients had significantly greater HIV knowledge (OR 4.59; 95% CI 1.72 to 12.25; p=.002) and knowledge of PMTCT (OR 3.52;

						95% CI 1.29 to 9.64; p=.014).
Patil et al., 2017 ¹⁶⁹	Malawi and Tanzania	Pilot RCT 2014-2015	>15yo Malawi N=91 Tanzania N=102 Two rural clinics in central Malawi and one urban clinic in Dar es Salaam, Tanzania	Group antenatal care plus (CenteringPregnancy Plus) Standard individual antenatal care (four-visit focused antenatal model, six-week postpartum visit)	pregnancy-related empowerment	In Malawi, GPNC patients had higher pregnancy related empowerment scores than those in IPNC (B 15.29; p<.0001). In Tanzania, pregnancy related empowerment scores were equivalent in both types of care models.
Liese et al., 2021 ¹⁷⁰	Malawi and Tanzania	Pilot RCT 2014-2015	>15yo Malawi N=91 Tanzania N=102 Two rural clinics in central Malawi and one urban clinic in Dar es Salaam, Tanzania	Group antenatal care plus (adapted CenteringPregnancy Plus) Standard individual antenatal care (four-visit focused antenatal model, six-week postpartum visit)	Occurrence of seven routine care practices (ex. assessment of gestational age at every visit and receiving medication for malaria), receiving thirteen key health promotion topics (ex. eating health and malaria prevention)	GPNC patients were more likely to have received all seven services (OR 6.20; 95% CI 2.81 to 13.94; p<.0001) and all 13 education topics (OR 27.58; CI 6.87 to 110.73; p<.001).
Jeremiah et al., 2021 ¹⁷¹	Malawi and Tanzania	Pilot RCT 2014-2015	>15yo Malawi N=91 Tanzania N=102 Two rural clinics in central Malawi and one urban clinic in Dar es Salaam, Tanzania	Group antenatal care plus (adapted CenteringPregnancy Plus) Standard individual antenatal care (four-visit focused antenatal model, six-week postpartum visit)	Communication with partner about sexual health topics (safer sex, HIV testing and family planning), reported partner HIV testing	GPNC was associated with increased communication with partner about sexual health topics (OR 4.17; 95% CI 2.22 to 7.83; p=0.008). Difference in report of partner HIV testing did not reach significance.
Sayinzoga et al., 2021 ¹⁷²	Rwanda	Cluster RCT	N=8,845 36 pair-matched	group antenatal care	Mean gestational length, Adherence to	Length of gestation was equivalent between GPNC patients and IPNC

		2017-2019	health care centers	Individual antenatal care (four visit focused antenatal model)	recommended prenatal and postpartum care visits, preterm birth, caesarean section, proportion identified as at risk during prenatal care	patients. Rate of preterm birth and cesarean birth were also similar between study arms. GPNC patients were more likely to attend at least three prenatal care visits (80.7% vs. 71.7%, p=0.003). While IPNC patients were more likely to attend a postnatal care visit (40.1% vs. 29.7%, p=0.003).
--	--	-----------	---------------------	--	--	---

Table 2.8 Observational studies examining group prenatal care

Author(s), Year	Design & Study Years	Participant Characteristics, N & Setting	Intervention & Comparison	Matching Technique	Outcomes	Main Findings
Cunningham et al., 2019 ¹⁷⁴	Retrospective cohort study 2009-2016	No history of PTB GPNC N=1,384 IPNC N=5,055 Vanderbilt University Medical Center a large metropolitan hospital	Group prenatal care (Expect With Me or CenteringPregnancy) Individual prenatal care	Propensity score greedy matching	Preterm birth and low birth weight	GPNC was associated with reduced risk of preterm birth (RR 0.63; 95% CI 0.49 to 0.81) and low birth weight (RR 0.62; 95% CI 0.47 to 0.81). Among women who attended five or more GPNC visits, risk of preterm birth decreased by 68% (RR=0.32; 95% CI 0.22 to 0.45) and low birth weight by 66% (RR=0.34; 95% CI 0.23 to 0.50).
Crockett et al., 2019 ¹⁷⁵	Retrospective cohort study 2013-2017	14-48yo GPNC N=3,456 IPNC N=11,870 13 healthcare practices in SC	Group prenatal care (Centering Pregnancy) Individual prenatal care	Preferential within cluster matching propensity score method	Preterm birth, low birth weight, admission to NICU	GPNC was associated with significant reductions in risk of preterm birth (absolute risk difference -3.2%; 95% CI -5.3% to 1.0%; p=.004), low birth weight (absolute risk difference -3.7%; 95% CI -5.5 to -1.8; p<.001) and NICU admission (absolute risk difference -4.0%, 95% CI -5.6 to -2.3%; p<.001). Benefits of GPNC were more pronounced among the as-treated sample. The

						effect of GPNC was similar for black and non-black patients except in the intention-to-treat analysis for NICU admissions where black women demonstrated greater improvement (Non-black IPNC 8.9% risk vs. GPNC 5.2% risk; Black IPNC 8.8% risk vs. GPNC 7.8%).
Dubay et al., 2020 ¹⁷⁸	Retrospective Cohort study 2014-2016	Medicaid covered women GPNC N=362 IPNC N=28,671 11 group prenatal care sites	Group prenatal care (usually following a CenteringPregnancy model) Medicaid covered women who received typical care	Propensity score reweighted matching	Preterm birth, low birth weight, cesarean section, vaginal birth after cesarean section (VBAC), care costs	GPNC patients were found to have similar rates of preterm birth, low birth weight, cesarean section and VBAC as the comparison group. Expenditure for GPNC patients in the prenatal period were less than the average for women in the comparison group (p<.001).
Lewis et al., 2021 ¹⁷⁶	Type 1 hybrid effectiveness-implementation trial 2014-2016	Low medical risk GPNC N=577 IPNC N=1825 3 clinics in Detroit, MI and Nashville, TN	Group prenatal care (Expect With Me) Individual care patients	Augmented inverse probability weighting (AIPW)	Preterm birth, low birth weight, Small for gestational age and admission to NICU	GPNC patients had lower risk of preterm birth (6.4% vs. 15.19%; RR 0.42; 95% CI 0.29, 0.54), low birth weight (4.3% vs. 11.6%; RR 0.37; 95% CI 0.24, 0.49) and admission to NICU (9.4% vs. 14.6%; RR 0.64; 95% CI 0.49, 0.78).
Heberlein et al., 2021 ¹⁷⁷	Retrospective cohort study Not stated	Medically high risk GPNC N=1,084 IPNC N=4,538 21 obstetric practices in SC	Group prenatal care (Centering Pregnancy) Individual prenatal care	Propensity score differential within matching approach to match women within the same practice	Preterm birth, low birth weight or NICU admission	Receiving GPNC at either level of treatment exposure was associated with reduced risk of NICU admission (any exposure: 10.2 vs. 13.8%; OR 0.71; p<.0001 and minimum threshold: 8.4 vs. 15.9%; OR 0.48; p<.001). GPNC patients attending five or more sessions had a reduced risk of preterm birth (11.4 vs. 18.4%; OR 0.57; p<.001). Care models were

						associated with similar infant birth weight
--	--	--	--	--	--	---

Table 2.9 Studies examining characteristics associated with interest or participation in group prenatal care

Author(s), year	Aim	Design & Study Years	Participant Characteristics, N & location	Groups Compared	Characteristics	Findings
Weber et al., 2015 ²⁰⁶	Determine if pregnant adolescents interested in GPNC have different characteristics.	Cross sectional survey 2009-2013	<21yo, Receiving IPNC N=153 CO, US	interested vs. not interested	Demographics (age, race and ethnicity, education, and BMI), Psychological (social support, depression, stress, and substance use), reproductive variables (gravity and parity) and reasons for pregnancy (a proxy for pregnancy intention)	61.4% of women reported being interested in GPNC. Younger (16 and younger) (25.5 vs. 6.8%, OR 4.7, 95% CI 1.6 to 14.4) and primigravid (81.9 vs. 59.3%; OR 3.1, 95% CI 1.5 to 6.5) adolescents more likely to be interested in GPNC. Adolescents who smoked (33.9 vs. 12.8%, OR 0.3, 95% CI 0.1 to 0.6) and wanted the pregnancy were more likely not to be interested in GPNC (47.1 vs. 19.8%, OR 0.3, 95% CI 0.1 vs. 0.6).
McDonald et al., 2016 ²⁰⁷	To determine the likelihood of participating in GPNC and associated factors.	Cross sectional survey 2013	Medically low risk, receiving IPNC N=477 Ontario, Canada	"Probably" or "definitely" likely to participate in GPNC vs. "unsure" "probably not" or "definitely not" likely to participate	maternal age, household income, education level, ethnicity, marital status, time with care provider, patient report of current IPNC characteristics, satisfaction with receiving helpful information about pregnancy, importance of women centeredness in PNC	49.2% (95% CI 44.6-53.6%) of participants reported they were "definitely" or "probably" likely to participate in GPNC. Women with a post-secondary of higher education level (aOR 1.84 95% CI 1.05 to 3.24), who had not yet discussed labor with their care provider (aOR 1.67 95% CI 1.12 to 2.44), and who valued women centeredness of care as "fairly important" (aOR 2.81, 95% CI 1.77 to 4.49) or "very important" (aOR 4.10, 95% CI 2.45 to 6.88) were more likely to report a high likelihood of GPNC participation.

Cunningham et al., 2017 ²⁰⁹	To identify determinants of GPNC attendance.	Secondary analysis of cluster RCT 2008-2012	14-21yo, receiving GPNC N=547 NY,US	Percent of GPNC sessions attended	Age, race and ethnicity, country of birth, school enrollment, employment status, relationship status number of children, food and housing insecurity, maternal comorbidities (preexisting diabetes, gestational diabetes and pregnancy induced hypertension)	Being born outside the US was associated with higher GPNC attendance (B(SE) 11.46(3.46), p=0.001).
Francis et al., 2019 ²¹⁰	Explore the maternal characteristics associated with low attendance among women randomly assigned to IPNC and GPNC.	analysis of data from ongoing RCT 2016-2018	Medically low risk women, randomly assigned GPNC or IPNC N=992 SC, US	low attendance (attending less than five visits in assigned care) vs. normal attendance	Demographic, psychosocial and lifestyle characteristics (prenatal distress, prenatal anxiety, depression symptoms, pregnancy intention, smoking before and during pregnancy, alcohol, education, employment, income)	GPNC patients with lower perceived family support were more likely to have low attendance in assigned care (p=0.01). While IPNC patients who smoked in early pregnancy were less likely to have low attendance in assigned care (p=0.02). The primary reasons for low attendance in IPNC was leaving the practice (34.04%), abortion or miscarriage (12.77%) and moving out of the area (11.70%). Scheduling challenges (23.19%) and preference for non-group setting (16.43%) were the primary reasons for low attendance in GPNC.
Berman et al., 2020 ²⁰⁸	Examine characteristics and perceptions of GPNC associated with likelihood	Cross sectional survey Not stated	Receiving IPNC N=197 CO, US	Three levels of likelihood (low, moderate and high)	Sociodemographic (age, race, education, marital status, employment status, insurance)	16.2% of patients reported a low likelihood, 44.9% a moderate likelihood and 38.9% a high likelihood of participating in GPNC. Characteristics between groups were

	to participate in GPNC using a health belief model framework.				type, and whether current partner was the father of the child), psychosocial (smoking, family functioning, social support, sense of control over life events) and reproductive (gravity, parity, age of living children, gestational age, whether pregnancy was unplanned)	similar. For patients reporting high likelihood, benefits reported outweighed barriers. For those reporting low likelihood, barriers outweighed benefits and for patients reporting moderate likelihood benefits and barriers were balanced.
Wagijo et al., 2021 ²¹¹	Explore the characteristics associated with GPNC uptake and attendance.	Stepped-wedge cluster RCT 2013-2016	Attending midwifery or hospital practice N=1647 Leiden, Netherlands	GPNC participant vs. non-GPNC participant	Demographic (age, ethnicity, religion, marital status, education, work status of participant and partner and parity) health behavior (healthy eating, physical activity, dental care, smoking status, alcohol use and drug use) psychosocial (stress, coping, social support, lifestyle and pregnancy knowledge), health care facility	Nulliparous women (aOR 2.74, 95% CI 2.08 to 3.60), women 22–26-year-old (aOR 1.59, 95% CI 1.10-2.29), co-habituating without being married/in a registered partnership (aOR 1.40, 95% CI 1.07 to 1.82) and those reporting average or high levels of stress (Average: aOR 1.45, 95% CI 1.04 to 2.02; Above average: aOR 1.42, 95% CI 1.08 to 1.87) were more likely to participate in GPNC. Women who stopped smoking before pregnancy intake (aOR 0.70, 95% CI 0.54 to 0.91), scored below average on lifestyle and pregnancy knowledge (aOR 0.56, 95% CI 0.41 to 0.78) were less likely to participate in GPNC. The primary reasons women indicated for why they

						<p>did not want to participate in GPNC were, they did not want to be in a group (21%), group consumed too much time (12% and they had no daycare for children (5%). Reasons for participation in GPNC included to receive information about pregnancy and birth (41%), to share their experience with others (38%), for fun and socializing (26%) and to know more people (24%). No differences were found in the characteristics of women who had higher and lower attendance.</p>
--	--	--	--	--	--	---

Table 2.10 Studies examining online pregnancy forums through analysis of posts

Author, year	Aim	Population of focus	Sample	Analysis Methods	Findings/Themes
Frederiksen et al., 2008 (253)	Explore perspectives on pelvic girdle pain (PGP) in pregnancy.	Pelvic girdle pain	Barnimagen, Norwegian forum for PGP n=1,650	Thematic analysis	<ul style="list-style-type: none"> • New bodily sensations • Fear • How much to endure • Lack of acknowledgement
Evans et al., 2012 ²⁵⁵	Examine the perceived value and types of social supports that characterize the discussions of women who participate in postpartum depression (PPD) online discussion groups.	Postpartum depression	Postpartum depression online support group identified through Goggle query, 6-month period n=512	Directed content analysis	<ul style="list-style-type: none"> • 41.6% emotional support (giving hope, sanctuary for honesty, affection, and empathy) • 37.5% informational support (seeking reassurance and validation, peer experts providing information, medication treatment advice) • 20.9% instrumental support
Sherman & Greenfield, 2013 ²⁴¹	Examine the type and nature of posts on online teen pregnancy and	Adolescents	Four message boards for pregnant and mothering teens identified through Google query,	Mixed methods content analysis	<ul style="list-style-type: none"> • 64% community-oriented posts • 38% solicited pregnancy or motherhood advice

	motherhood message boards.		randomly selected threads N=200		Response sentiment: <ul style="list-style-type: none"> • 36% responses explicitly positive • 63.4% responses neutral • 0.6% responses explicitly negative
Konheim-Kalkstein et al., 2015 ²³⁴	Identify the specific types of information and support that woman considering vaginal birth after cesarean section (VBAC) seek online compared with other pregnant persons.	VBAC	Babycenter, discussion board “VBAC support” and “Pregnancy”, first 300 initial posts on or after January 1, 2013 n=600 initial posts	Content analysis	Greater discussion of: <ul style="list-style-type: none"> • Communicating with health care providers • Sharing of birth stories • Involvement (frequency of posts) on the VBAC board compared to the general pregnancy board.
Alang & Fomotar, 2015 ²⁵³	Identify the functions and perceived benefits of the group and to investigate the shared experiences of lesbian birth mothers with postpartum depression (PPD).	Lesbian birth mothers with PPD	Same sex families forum, PPD subforum n=1,421	Ethnography and content analysis (directed and conventional)	Forum functions: <ul style="list-style-type: none"> • Disclosure and companionship • Ways of coping Experience/concerns: <ul style="list-style-type: none"> • Reluctance to seek treatment • Public perceptions about motherhood abilities • Stigma and mental illness • Medications • Perseverance • Combined conditions
Carlsson et al., 2016 ²³²	Explore experiences described by posters before during and after termination of pregnancy due to fetal anomaly.	Termination of pregnancy due to fetal anomaly	2 active Swedish virtual communities identified through google query followed by manual and keyword searches, 6-year period n=1,623	Inductive manifest Content analysis	Before termination: <ul style="list-style-type: none"> • Emotional shock • Difficult decision During termination: <ul style="list-style-type: none"> • Compassionate care from present caregivers • Emotional and physical pain • Lack of understanding about termination of pregnancy • Viewing the fetus After termination:

					<ul style="list-style-type: none"> • Coming to terms with decision • Perinatal loss • Fears of recurrence • Longing for a child
Moore et al., 2016 ²³³	Examine stigma and disclosure in forums and describe any potential disadvantage of forum use.	Antenatal and postnatal depression	Mumsnet, threads from the antenatal and postnatal depression sections, 6-month period n=1,546	Deductive thematic analysis	<ul style="list-style-type: none"> • Internal stigma • External stigma • Treatment stigma • Negative experiences of disclosure with health care providers
Yamada et al., 2016 ²⁴⁵	Characterize the information women sought over time about pumping on an online parenting discussion forum	Pumping /Breastmilk	Babycenter, April 2014 “birth club”, key word search of posts that included questions about pumping n=543	Thematic analysis	<ul style="list-style-type: none"> • Changing and purchasing pumps • Storing and preparing pumped breastmilk • Strategies for and difficulties with pumping and integrating pumping into work • Stopping pumping
Petrovska et al., 2017 ²³⁵	Examine how women use internet discussion forums to find out information about vaginal breech birth and increase understanding of how vaginal breech birth is perceived among women.	Vaginal breech birth	50 threads in 2013 identified through google alert for search terms n=382 initial posts	Thematic analysis	<ul style="list-style-type: none"> • Testing the waters- which way should I go? • Losing hope for the chance of a normal birth • Seeking support for options- who will listen to me • Considering vaginal breech birth- a risk choice? • Staying on the “safe” side – caesarean section as a guarantee • Exploring the positive potential for vaginal breech birth
Ruthven et al., 2018 ²⁴⁸	Explore the information needs of young first-time mothers and the way young first-time mothers	Young first-time moms	Netmums, “Young parents support” forum, 1-year period n=266	Content Analysis	<ul style="list-style-type: none"> • Child-development and health • Providing a good environment (Education, finance, housing, legal, professional support, working

	ask for information online.				and maternity leave) <ul style="list-style-type: none"> Relationships (managing existing relationships, making new relationships)
Gui et al., 2017 ²³⁸	Understand why pregnant patients seek peer support online, how they seek peer support and how peers respond to them over the course of pregnancy	General	Babycenter, 3 “mommy mentors” forums based on pregnancy trimesters n=600	Grounded theory	<p>Motivations:</p> <ul style="list-style-type: none"> Limited access to healthcare professionals Frustration with their own healthcare providers Limited access to offline support Mismatch between information obtained online or from books and their own experience <p>Types of support sought:</p> <ul style="list-style-type: none"> Advice Formal pregnancy-related knowledge Informal pregnancy-related knowledge Reassurance emotional support <p>Replied received:</p> <ul style="list-style-type: none"> sharing experiential knowledge passing on other healthcare providers’ opinions action based on peer’s responses
Yamada et al., 2019 ²⁴⁶	Characterize the questions mothers ask each other online related to the adequacy of milk they pumped and provide to their infants.	Pumping /Breastmilk	Babycenter, April 2014 “birth club”, key word search of posts that included questions about pumping n=543	Thematic analysis	<ul style="list-style-type: none"> Pumping an adequate amount of milk Providing an adequate amount of pumped milk Perception of insufficient pumping and the cessation of exclusive human milk feeding

Ghouri et al., 2019 ²⁴⁹	Explore women's perceptions of urinary tract infections (UTIs) and antibiotic use during pregnancy.	UTIs and antibiotic use	Mumsnet, identified by key word searches, 5-year period N=202 threads	Thematic analysis	Primary theme: <ul style="list-style-type: none"> Pre-natal attachment/bond during pregnancy Subthemes <ul style="list-style-type: none"> Illness perceptions Safety of antibiotics Coping mechanisms
Rezaallah et al., 2019 ²³⁷	Examine the content of posts concerning pregnancy and use of muscular sclerosis (MS) medicine.	MS and medication	21 forums identified through a digital monitoring platform of medical product mentions, 3-year period n=71	Content analysis	<ul style="list-style-type: none"> Expressing personal experiences with MS and medication use during the reproductive period Seeking and sharing advice about the use of medicines Progression of MS during and after pregnancy Discussing concerns about MS medications during the reproductive period Querying the possibility of breastfeeding while taking MS medications Commenting communications with physicians
Lebron et al., 2019 ²⁴⁷	Examine an online breastfeeding support forum to understand the information seeking and sharing practices of users.	Breastfeeding	Babycenter, "Breastfeeding Support and Help" community forum, 10-day period n=1,703	Content analysis	Information seeking: <ul style="list-style-type: none"> Nursing (feeding challenges, supply issues, feeding schedule and duration, excretion issues, general) Expressed milk *pumping, storing milk) Nursing effects on mother (physical health, nipple) Information sharing: <ul style="list-style-type: none"> Content (knowledge,

					<p>experiences, encouragement)</p> <ul style="list-style-type: none"> • Process (using interviewing questions and agreeing with previous posts)
Denton et al., 2020 ²⁵⁰	Examine the type of feedback women receive on an internet message board about psychotropic medication use during pregnancy	Psychotropic medication use	Babycenter, posts identified by keyword search of psychotropic medications, 3-month period n=1728	Consensual Qualitative Research approach	<ul style="list-style-type: none"> • Personal anecdotes • Suggesting alternative solutions • Directives • Judgement • Social support • Skepticism & mistrust • Risk vs. benefits
Ellis & Roberts, 2020 ²³⁹	Explore online pregnancy forum health-related use and evaluate quality of information shared.	General	Mumsnet and Netmums, first 20 threads from each month, 1-year period n=480	Thematic analysis and quality assessment	<p>Motivations for engagement:</p> <ul style="list-style-type: none"> • Desire for lived experience • Unlimited access • Opportunity to express emotions <p>Accuracy:</p> <ul style="list-style-type: none"> • 54.7% accurate • 20.9% erroneous, incomplete or misleading • 24.3% lacking credible evidence • 5.5% potentially harmful
Chivers et al., 2020 ²⁴⁰	Examine the public discourse of a perinatal cohort to understand unmet health information and support needs and the impacts on mothering identity and social dynamics in context of COVID-19.	COVID-19	Australian new mom forum identified through google query, posts related to COVID-19, 5-month period n=831	Thematic analysis, sentiment analysis and word frequency count	<ul style="list-style-type: none"> • Heightened distress related to a high-risk external environment • Despair and anticipatory grief due to deprivation of social and family support and bonding rituals • Altered family and support relationships • Guilt-tampered happiness • Family future postponed
Wexler et al., 2020 ²³⁶	Apply machine learning	General	WhattoExpect, seven “birth club” forums,	Automatic natural language	<p>Largest topic categories:</p> <ul style="list-style-type: none"> • Maternal health 45%

	methods to analyze online pregnancy forums to better understand how women seek information from a community of online peers during pregnancy.		6-month period, initial posts only n=262,238	processing, Latent Dirichlet Allocation (LDA)	<ul style="list-style-type: none"> • Baby-related topics 29% • People/relationships 10% Throughout pregnancy: <ul style="list-style-type: none"> • Pain First trimester: <ul style="list-style-type: none"> • Miscarriage Third trimester: <ul style="list-style-type: none"> • Labor
Du et al., 2021 ²⁵¹	Analyze the biopsychosocial experiences of postpartum women regarding pelvic organ prolapse (POP).	Pelvic organ prolapse	Reddit, "BeyondtheBump" subreddit, queried threads related to POP, 5-year period n=418	Grounded theory	<ul style="list-style-type: none"> • Lack of general knowledge of prolapse • Needing support and care • Symptoms and the difficulties of life with pelvic prolapse • POP is disruptive debilitating condition • Women are self-driven in addressing pelvic prolapse for themselves • Motivated to increase awareness of prolapse as a condition
Liang et al., 2021 ²⁵²	Identify the characteristics of women in an online health community with opioid use or misuse during pregnancy and the self-management support needs of these mothers.	Opioid use/misuse	Online health community, queried for mentions of pregnancy and opioid related drug names, randomly sampled posts 9-year period n=200	Thematic analysis	Self-management support needs <ul style="list-style-type: none"> • Protocols for self-managed withdrawal • Pain management safety during pregnancy • Hospital policies and legal procedures related to child protection • Strategies for navigating offline support systems
Rouhi et al., 2021 ²⁵⁷	Explore what support is given to mothers who have posted	Post-childbirth maternal morbidities	Post-childbirth online forum, 2-year period n=332	Directed content analysis and thematic analysis	Overarching themes: <ul style="list-style-type: none"> • Postpartum adjustment • The fallacy of normalcy

	questions about post-childbirth morbidities.				<p>Motivation:</p> <ul style="list-style-type: none"> • Problem disclosure • Anyone in the same boat • Request for advice <p>Support</p> <ul style="list-style-type: none"> • 56.9% emotional support • 22.7% practical support • 20.4% informational support
Chivers et al., 2021 (241)	Explore the conversations of new mothers on web-based parenting forum to investigate what topics and concerns are being discussed.	Postpartum	Australian Pre and post birth forums, first 20 posts from each of the 13 “Birth clubs”, 1-week period n=260	Thematic analysis, word frequencies and sentiment analysis	<p>Most common topic:</p> <ul style="list-style-type: none"> • Infant care (feeding and sleep) • Maternal care (birth recovery, breastfeeding concerns, and interconception) <p>Cycle of learning five phases:</p> <ul style="list-style-type: none"> • Help seeking • Solution ideation • Testing and skill development • Consolidation and empowerment • Improved mental well-being
Aston et al., 2021 ²³¹	Explore how first-time mothers choose to access or not access different postpartum supports.	First-time mothers	Babycenter, first time mothers in Nova Scotia, 6-month period n=724	Discourse analysis	<ul style="list-style-type: none"> • Personal narratives: empathy, encouragement, and information • Socialization • Blurring the boundaries of online and off-line networks • Developing community
Dalton & Gruber, 2022 ²⁵⁴	Examine types of uncertainty that emerge in pregnancy after loss (PAL) and how women manage uncertainty	Pregnancy after loss	Reddit, subreddit “PregnancyAfterLoss”, posts containing mentions of uncertainty, 4-month period n=636	Thematic analysis	<ul style="list-style-type: none"> • Physiological/medical uncertainty (ambiguous test results, bleeding, inconsistent symptoms and fetal movement) • Emotional uncertainty (denial and detachment, experiencing

					<p>dialectical cycles of emotion, comparison to non-loss “normals” and waiting in limbo)</p> <ul style="list-style-type: none"> • Social uncertainty (encounter distressing interactions, manage emotional incongruity and announce pregnancy) • Uncertainty management and coping strategies (direct information seeking, bracing, mantras and accepting uncertainty)
Kim et al., 2022 ²⁵⁶	Explore the predominate types of social support shared in an online social support community for Korean mothers.	PPD	MomsholicaBaby, PPD related message board for Korean mothers, 3-month period n=3,073	Content analysis	<ul style="list-style-type: none"> • Tend to provide social support (65.5%) rather than seek support (9.2%) • Emotion focused coping strategies (71.6%) more prevalent than problem-focused coping strategies (6.3%) or both (18%)
Beyers-Carlson et al., 2022 ²³⁰	Explore the online world of second time mothers using online pregnancy forum.	Second time mothers	Babycenter, two “birth clubs” specific to second-time parenting n=16,000	Latent Dirichlet Allocation analysis	<ul style="list-style-type: none"> • Expressed same concerns as first-time mothers (pregnancy, prenatal testing, choosing a baby name, the gender reveal and overall health of the baby) • Also expressed unique concerns (new role as the mother of two young children, ability to care for both children and whether they could love another child as much as they loved the first)

Figure 2.1 Intersectionality perspective of discrimination framework

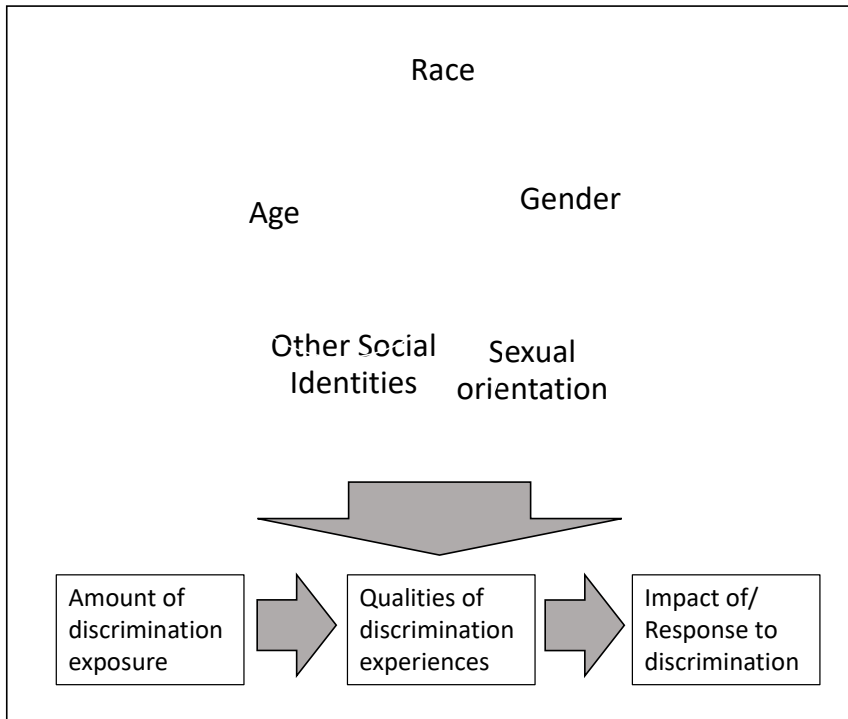


Figure 2.2 CenteringPregnancy essential elements and content

Essential elements: ¹⁴⁶

1. Health assessment occurs within the group space.
2. Women are involved in self-care activities.
3. A facilitative leadership style is used.
4. Each session has an overall plan.
5. Attention is given to the core content; emphasis may vary.
6. There is stability of group leadership.
7. Group conduct honors the contribution of each member.
8. The group is conducted in a circle.
9. Group composition is stable, but not rigid.
10. Group size is optimal to promote the process.
11. Involvement of family support people is optional.
12. Opportunity for socialization within the group is provided.
13. There is ongoing evaluation of outcomes.

Discussion topics: ¹⁴⁷

- Body changes during pregnancy
- Food and other things to avoid while pregnant (e.g. smoking, alcohol and drug use)
- Nutrition, exercise, and oral health
- Fetal development
- Stress management and relaxation
- Intimate partner violence and abuse
- Family adjustment and preparing siblings for baby
- Preterm labor
- Signs of early labor
- Labor planning, decisions and coping with labor pain
- Perinatal mood disorders
- Breastfeeding

- Bonding with baby, soothing and providing comfort
- Family planning and safe sex
- Parenting
- Developmental milestones and newborn safety

CHAPTER THREE
METHODOLOGY

Research Questions

This dissertation includes three independent studies with the following research questions and specific aims:

Research Question 1. What are the intersectional discrimination experiences of pregnant persons? Are pregnant persons experiencing intersectional discrimination at an increased risk for adverse perinatal health outcomes?

Specific Aim 1a. Utilizing an intersectional approach, examine whether pregnant patients can be classified based on multifaceted discrimination experiences through latent class analysis.

Specific Aim 1b. Explore the association of latent discrimination classifications with risk of adverse maternal and neonatal birth outcomes through multivariate logistic regression.

Research Question 2. For what patients is the alternative prenatal model group prenatal care a good fit?

Specific Aim 2a. Investigate whether GPNC attendance differs by patient sociodemographic, psychosocial and health characteristics through quantitative analysis of patient surveys and EMR data.

Specific Aim 2b. Compare patient perceptions of care and the match between prenatal care services received and patient needs among patients receiving IPNC and GPNC through qualitative analysis of patient interviews.

Research Question 3. To what degree are pregnant persons discussing health in online peer communities?

Specific Aim 3a. Explore prevalent topics of discussion in three popular online pregnancy forums through topic modeling.

A summary of study methodology for each of the three studies is provided in Table 1.

Centering and Racial Disparities Trial

Manuscript one and two are secondary analyses of data collected in the Centering and Racial Disparities (CRADLE) randomized controlled trial.¹² The primary objective of the CRADLE study was to assess whether participation in GPNC reduced rates of preterm birth and low birthweight, as well as black-white disparities in these rates relative to IPNC. CRADLE study participants were recruited from a single hospital affiliated obstetrics and gynecology practice located in Greenville, South Carolina serving a large medically underserved population. Study recruitment took place between February 2016 and March 2020. Patients were eligible for inclusion if they were between the ages of 14 and 45, entered care prior to 21 weeks gestational age and were able to be enrolled by 24 weeks gestational age. Patients were excluded from participation if they had medical or pregnancy complication that would preclude prenatal care and delivery by a nurse practitioner or nurse midwife (e.g. pregestational diabetes mellitus, chronic hypertension requiring medication, any disease requiring immunosuppression, a body mass index of $>50\text{kg/m}^2$, multiple gestation, anticipated a planned preterm delivery or planned cerclage or lethal fetal anomalies) or medical, social or behavioral conditions that would preclude participation in group care (e.g. active pulmonary tuberculosis, current incarceration, or severe uncontrolled psychiatric illness). Once enrolled, participants were randomly assigned to attend either standard individual prenatal care (IPNC) or group prenatal care (GPNC), stratified by self-reported maternal race and ethnicity. Participants were recruited upon entry to prenatal care and were followed through 12-weeks postpartum. Data was collected at three time points: 1)

an initial survey at the time of enrollment, 2) a second survey between 30 and 40 weeks gestation, and 3) medical chart abstraction 12-weeks postpartum. Survey instruments included baseline demographic questions and validated psychosocial and behavioral measures. Medical and delivery information were collected through both manual chart abstraction and automated query of the electronic medical record (EPIC Systems INC, Verona WI). Participants were compensated \$25 for their participation at the time of survey 1 and survey 2 if they completed at least five visits in their assigned model of prenatal care.

CRADLE Study Process Evaluation

Manuscript two also included analysis of data collected in the CRADLE Study Process Evaluation (CSPE). Coordinated process evaluation efforts were conducted in conjunction with the CRADLE study, with the aim of assessing fidelity to the CenteringPregnancy model. These efforts included semi-structured individual interviews with a purposeful subsample of patients attending GPNC and IPNC. Eligibility was determined by attendance in assigned care with CRADLE study patients prioritized. GPNC patients were eligible for participation if they had attended 2 or more GPNC sessions and IPNC patients if they attended at least one IPNC visit prior to 16 weeks gestational age. Additional inclusion criteria included access to a cellphone and no intention to move prior to delivery. Interview guide questions focused on the patients experience in prenatal care and were arranged to follow the visit/session process differing by care model. Participants were asked to describe their most recent appointment including what they found most meaningful and their relationship with their provider and in the case of patients attending GPNC group members. Interviews were audio recorded and took place in person and in rare cases via telephone. Participants received a \$5 compensation for each interview.

Manuscript One

Study one was a secondary analysis of data collected in the CRADLE study. Among this relatively large sample of pregnant patients with psychosocial and pregnancy outcome information, we aimed to examine whether mutually exclusive subgroups of pregnant patients could be formed based on discrimination experience and to determine whether these subgroups differed in risk of adverse pregnancy outcomes such as preterm birth and preeclampsia. We investigated these aims using the innovative statistical approach of Latent Class Analysis (LCA). LCA is a data and theory driven approach that probabilistically assigns individuals to subgroups based on responses to a set of observed categorical variables (indicator variables).³ Cradle study participants were excluded from the current analysis if they experienced spontaneous abortion or if they were missing data on all indicator variables.

Measures

Indicator Variables. Indicator variables used to define unobserved latent class membership were comprised of patient response to the adapted 11-item Everyday Discrimination Scale (EDS).⁴ The EDS was administered as a component of the baseline survey. Respondents are asked the frequency with which they experience 10 forms of day-to-day mistreatment (never, rarely, sometimes and often). If respondents indicate any discrimination, they are asked to indicate an attribution for their mistreatment and can select one or more of the following social identities: gender, race and ethnicity, insurance and Medicaid status, ancestry and national origin, age, religion, weight, some other aspect of physical appearance, sexual orientation, education, and income. A binary variable of discrimination frequency was formed representing indication of never vs. rarely, sometimes, or often experiencing discrimination. Each attribution for

discrimination was coded as a binary variable with possible responses of either yes or no. Attributions with low prevalence were combined to form an other discrimination variable.

Outcome Variables. The primary outcome was a composite measure of adverse perinatal health outcomes (APHOs). A binary variable was created representing indication of none vs. one or more of the following seven outcomes: preterm birth (PTB; delivery at <37 weeks of gestation), low birthweight (LBW; infant birthweight of <2500 g) small for gestational age (SGA; birthweight below the 10th percentile for gestational age), infant admission to the neonatal intensive care unit (NICU), 5-minute Apgar score <7, pre-eclampsia and patient admission to the intensive care unit (ICU). Individual components of the APHOs composite and postpartum depression symptoms (PPDS) were considered as secondary outcomes. PPDS were measured via the Edinburgh Postnatal Depression Scale (EPDS)⁵ with a score of 13 or greater considered to represent clinically concerning depressive symptom. Outcome variables were abstracted via electronic medical record review. The EPDS was administered at the postpartum visit and scores manually abstracted from visit notes.

Sociodemographic Variables. Sociodemographic variables included race and ethnicity; age; Medicaid eligible; educational attainment; current relationship with baby's father, nativity, parity; and body mass index (BMI) at initial prenatal care visit. Participant race and ethnicity was self-identified on multiple questions used by the US Census Bureau, which allowed participants to select multiple categories, as well as to provide a written response.⁶ Race and ethnicity was categorized as Black, Hispanic, White and "Other" race and ethnicity.

Statistical Analysis

Statistical analysis was performed in SAS (Version 9.4; SAS Institute, Inc, Cary, NC). Descriptive statistics were performed, and differences by race and ethnicity examined using X^2

tests. LCA Models were then estimated using SAS PROC LCA and the LCABootstrap Macro.⁷⁸ Models with 1 to 6 latent classes were tested and the best fitting model selected based upon interpretability and model fit statistics. Measurement invariance by race and ethnicity was assessed following a three-step approach, wherein a significant difference in likelihood ratios between constrained and unconstrained models indicates measurement invariance should be rejected and latent class modeling conducted separately. Class membership and item response probabilities were produced, and item response probabilities used to label classes. The Block, Croon and Hagenarrs (BCH) three-step approach was used to assess whether latent classes were associated with APHOs, applied separately for each outcome.⁹

Manuscript Two

Study two was a secondary analysis of data collected in the CRADLE study and coordinated CSPE participant interviews. Study two addressed the research question for what patients is group prenatal care a good fit? We addressed this question through a concurrent mixed methods study design. We aimed to investigate whether certain patient characteristics were associated with patterns of GPNC session attendance through quantitative analysis. Further, we sought to examine patient perceptions of model of care received through qualitative analysis of participant interviews. Following separate data collection and analysis, quantitative and qualitative findings were integrated. Participants assigned to IPNC were excluded from our quantitative analysis. No additional exclusion and inclusion criteria were applied to participant interviews.

Measures

Primary Predictors. In the CRADLE study, a variety of patient characteristics were collected. Selection of patient characteristics included in analysis was informed by previous

studies of GPNC attendance.¹⁰¹¹¹²¹³¹⁴¹⁵ Sociodemographic, psychosocial, and behavioral characteristics were self-reported on survey measures. Sociodemographic characteristics included maternal age, race and ethnicity, nativity, language, relationship status, educational attainment, school enrollment, employment status and health insurance status in the previous year. Psychosocial and behavioral characteristics included pregnancy intention, feelings about pregnancy, depressive symptomology,¹⁶ pregnancy specific anxiety,¹⁷ prenatal distress,¹⁸ neighborhood safety,¹⁹ housing instability,²⁰ housing issues,²¹ life stressors,²² everyday discrimination,⁴ support from the baby's father and support from family during pregnancy, substance use during pregnancy (cigarette smoking, alcohol use and marijuana use). Health characteristics were determined via electronic medical chart review and included parity, body mass index (BMI) at initial appointment, gestational diabetes (GDM), chronic hypertension (CHTN) and gestational hypertension (GHTN).

Primary Outcome. The primary outcome was GPNC session attendance. Participant prenatal care attendance was abstracted from the electronic medical record and a count variable of session attendance calculated.

Covariates. A measure of participant eligibility to attend GPNC sessions was calculated based on month of study enrollment and date of delivery. This calculation was informed by the Kotelchuck adequacy of prenatal care index,²³ but differed in that participants were eligible to attend a maximum of 10 GPNC sessions in accordance with the GPNC care model.

Statistical Analysis

Quantitative data analysis was conducted using SAS 9.4 (SAS Institute INC, Cary NC). Descriptive statistics including mean for continuous variables and frequency with percentages for categorical variables. The association between patient characteristics and session attendance

was assessed using Zero-inflated Poisson (ZIP) regression. The ZIP model assumes that excess zeros occur due to a separate process than count values and should therefore be modeled independently. The ZIP model therefore consists of two parts a Poisson count model and a logit model that predicts the log odds of excess zeros. An adjusted ZIP model was conducted controlling for the number of sessions participants were eligible to attend.

Qualitative Analysis

Transcripts were managed and analyzed using NVivo March 2020 release (QSR International Pty Ltd). Audio recording of participant interviews were transcribed verbatim and Spanish language interviews were translated to English. A reflexive thematic analysis of interviews was conducted following Braun and Clarke's six phase process.²⁴ One researcher read the transcripts in their entirety, becoming familiar with the data and making note of initial coding ideas. Two researchers then each independently coded a subset of interviews from patients in both care models, from researcher impressions a preliminary codebook was developed. The same one researcher then utilized the codebook to code the entire dataset, codes were organized, and initial themes generated. Preliminary themes were reviewed, and themes refined. Memos documenting decision rational were kept throughout the study creating an audit trail which was reviewed by the second researcher.

Manuscript Three

While study one and two analyzed data collected in a randomized controlled trial, the third dissertation study concentrated on a different dataset, user generated content from online forums. We aimed to explore themes discussed by peers in online pregnancy communities, with a particular emphasis on the topics relating to health using the text mining approach of Latent Dirichlet Allocation (LDA) topic modeling. LDA is a statistical method for analyzing the words

of texts to discover themes.²⁵ Data was extracted from three active online pregnancy forums (Babycenter.com, Whattoexpect.com and Thebump.com) over a year long period (January 2021-December 2021). The forums selected were identified through Google search results and a comparison of popularity in the US using a web analytic tool. Data was scrapped through the Sprinklr Inc. social media listening platform and a dataset formed that included title, message, date and time posted.

Statistical analysis

LDA is guided by two assumptions: 1) each document is a mixture of topics, and 2) each topic is a mixture of words. Documents in this case the text threads are modeled as a “bag of words” without consideration of word order. Processing and data analysis was conducted in R version 4.2.3. Analysis took place over five stages following Silge and Robinson five stage process for topic modeling in R: 1) gather data, 2) process data, 3) generate Document Term Matrix, 4) select topic number, and 5) implement and interpretate the LDA model.²⁶ Following the extraction of data from online forums, text processing was performed using the “tm” package in R. Documents were cleaned (converted to lowercase and punctuation, numbers and stop words removed), tokenized and duplicate threads removed. The collection of documents was stored as a Document Term Matrix, from which topic modeling was performed using the “topicmodels” package in R. To identify the best fitting number of topics, 8 models with 10 to 80 topics were estimated and interpretability compared. The model with distinct enough word clusters to assign labels but that did not produce overly similar topics was selected. Once a model was selected, the 15 words with the highest word-topic probability and the 15 threads with the highest document-topic probability were extracted for manual inspection. Two researchers independently inspected word clusters and representative threads assigning each topic a label and

indicated whether the topic pertained to health. Topic labels and health designations were then reviewed, and consensus reached on topic labels.

References

1. Crockett, A. H. *et al.* Group versus traditional prenatal care for improving racial equity in preterm birth and low birthweight: the Cradle randomized clinical trial study [Manuscript submitted for publication]. (2022).
2. Chen, L. *et al.* Centering and Racial Disparities (CRADLE study): rationale and design of a randomized controlled trial of centeringpregnancy and birth outcomes. *BMC Pregnancy Childbirth* **17**, 118 (2017).
3. Lanza, S. T., Collins, L. M., Lemmon, D. R. & Schafer, J. L. PROC LCA: A SAS Procedure for Latent Class Analysis. *Struct. Equ. Model. Multidiscip. J.* **14**, 671–694 (2007).
4. Williams, D. R., Yan Yu, Jackson, J. S. & Anderson, N. B. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *J. Health Psychol.* **2**, 335–351 (1997).
5. Cox, J. L., Holden, J. M. & Sagovsky, R. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br. J. Psychiatry J. Ment. Sci.* **150**, 782–786 (1987).
6. Wallman, K. K. & Hodgdon, J. Race and ethnic standards for Federal statistics and administrative reporting. *Stat. Report. Off. Fed. Stat. Policy Stand.* 450–454 (1977).
7. Dziak, J. J. & Lanza, S. T. *LcaBootstrap SAS Macro Users' Guide (Version 4.0)*. (University Park: The Methodology Center, Penn State, 2016).
8. Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A. & Collins, L. M. *PROC LCA & PROC LTA Users' Guide Version 1.3.2*. (University Park: The Methodology Center, Penn State, 2015).
9. Dziak, J. J., Bray, B. & Wagner, A. *LCA_Distal_BCH SAS Macro Users' Guide (Version 1.1)*. (The Methodology Center, Penn State, 2017).
10. Weber Yorga, K. D. & Sheeder, J. L. Which Pregnant Adolescents Would be Interested in Group-Based Care, and Why? *J. Pediatr. Adolesc. Gynecol.* **28**, 508–515 (2015).
11. Wagijo, M. R. *et al.* CenteringPregnancy in the Netherlands: Who engages, who doesn't, and why. *Birth* **49**, 329–340 (2022).
12. McDonald, S. D. *et al.* Why Are Half of Women Interested in Participating in Group Prenatal Care? *Matern. Child Health J.* **20**, 97–105 (2016).
13. Cunningham, S. D. *et al.* Group Prenatal Care Attendance: Determinants and Relationship with Care Satisfaction. *Matern. Child Health J.* **21**, 770–776 (2017).

14. Earnshaw, V. A. *et al.* Maternal Experiences with Everyday Discrimination and Infant Birth Weight: A Test of Mediators and Moderators Among Young, Urban Women of Color. *Ann. Behav. Med.* **45**, 13–23 (2013).
15. Francis, E. *et al.* Group Prenatal Care Attendance and Women’s Characteristics Associated with Low Attendance: Results from Centering and Racial Disparities (CRADLE Study). *Matern. Child Health J.* **23**, 1371–1381 (2019).
16. Radloff, L. S. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Appl. Psychol. Meas.* **1**, 385–401 (1977).
17. Guardino, Christine M. & Schetter, Christine Dunkel. Understanding Pregnancy Anxiety: Concepts, Correlates, and Consequences. *Zero Three* **34**, 12–21 (2014).
18. Lobel, M. *et al.* Pregnancy-specific stress, prenatal health behaviors, and birth outcomes. *Health Psychol.* **27**, 604–615 (2008).
19. Maternal, Child and Adolescent Health Programs. The Los Angeles Mommy & Baby Project. *Publichealth.lacounty.gov*
http://publichealth.lacounty.gov/mch/lamb/Survey/2016Survey/2016LAMB_Eng.pdf (2016).
20. Carrion, B. V. *et al.* Housing Instability and Birth Weight among Young Urban Mothers. *J. Urban Health* **92**, 1–9 (2015).
21. Blumberg, S. J., Bialostosky, K., Hamilton, W. L. & Briefel, R. R. The effectiveness of a short form of the Household Food Security Scale. *Am. J. Public Health* **89**, 1231–1234 (1999).
22. Centers for Disease Control and Prevention. PRAMS Questionnaires.
<http://www.cdc.gov/prams/Questionnaire.htm> (2014).
23. Kotelchuck, M. An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *Am. J. Public Health* **84**, 1414–1420 (1994).
24. Braun, V. & Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**, 77–101 (2006).
25. Blei, D. M., Ng, A. Y. & Jordan, M. I. Latent dirichlet allocation. *Adv. Neural Inf. Process. Syst.* (2001).
26. Silge, J. & Robinson, D. *Text mining with R: a tidy approach.* (O’Reilly, 2017).

Tables and Figures

Table 3.1. Summary of Methodology	
Study One: Discrimination and adverse perinatal health outcomes: A latent class analysis	Study Design: Quantitative analysis, secondary data analysis
	Data Source: Centering and Racial Disparities (CRADLE) Study
	Primary Aims: 1a) Use Latent Class analysis to examine patients' intersecting experiences of perceived discrimination, identifying heterogeneous subgroups among a sample of low-income pregnant women. 1b) Investigate whether latent class profiles are differentially associated with risk of adverse perinatal health outcomes.
	Inclusion Criteria: CRADLE study participants
	Exclusion Criteria: spontaneous abortion or missing data on all indicator variables
	Indicator Variables: Everyday Discrimination Scale items
	Primary Predictors: Latent Class designation
	Primary Outcomes: Composite measures of adverse perinatal health outcomes, individual composite components and postpartum depression symptoms
	Statistical Analysis: Latent Class Analysis (LCA) and Block, Croon and Hagenarrs (BCH) three-step approach
Study Two: For which patients is group prenatal care a good fit? A mixed methods study of group prenatal care attendance	Study Design: Mixed methods analysis, secondary data analysis
	Data Source: Centering and Racial Disparities (CRADLE) Study and CRADLE Study Process Evaluation (CSPE)
	Primary Aims: 2a) Determine whether rate of GPNC attendance differ by patient sociodemographic, psychosocial and health characteristics through quantitative analysis. 2b) Examine patient response to prenatal care received in IPNC or GPNC reflecting upon the fit of prenatal care with patient needs through qualitative analysis of participant interviews.
	Inclusion Criteria Quant: Cradle Study participants allocated to GPNC
	Inclusion Criteria Qual: CSPE individual interviews of patients attending IPNC and GPNC
	Primary Predictors: Patient sociodemographic, psychosocial and health characteristics
	Primary Outcomes: GPNC session attendance
	Statistical Analysis: Zero-inflated Poisson (ZIP) regression
	Qualitative Analysis: Thematic Analysis
Study Three: Investigating discussions of health in online forums during pregnancy through text mining	Study Design: Quantitative analysis (text mining)
	Data Source: User generated content scraped from 3 active online pregnancy forums (Babycenter.com, Whattoexpect.com and Thebump.com)
	Primary Aim: 3a) Describe the topics discussed in online communities of pregnant peers using text mining methods.
	Unit of Analysis: Thread (initial and response posts)
	Inclusion Criteria: Posted between January 2021 and December 2021
	Exclusion Criteria: Duplicate threads
Statistical Analysis: Latent Dirichlet Allocation (LDA)	

CHAPTER FOUR

MANUSCRIPT ONE

Title: Discrimination and Adverse Perinatal Health Outcomes: A Latent Class Analysis

Abstract

Introduction: An intersectionality framework recognizes individuals as simultaneously inhabiting multiple intersecting social identities embedded within systems of disadvantage and privilege. Previous research links perceived discrimination with worsened health outcomes yet is limited by a focus on racial discrimination in isolation. We apply an intersectional approach to the study of discrimination, examining the association with adverse perinatal health outcomes.

Methods: Data is from cohort of 2,286 pregnant persons: Black (n=933), Hispanic (n=471), White (n=853) and “Other” (n=29) from the CRADLE trial. Perceived discrimination was assessed via the Everyday Discrimination Scale (EDS) and perinatal health outcomes collected via electronic medical record review. Latent class analysis was utilized to identify subgroups of discrimination based on EDS item response and the rate of adverse perinatal health outcomes compared between subgroups using a Block, Croon and Hagenarrs three-step approach.

Results: Four discrimination subgroups were identified: no discrimination; general discrimination; discrimination attributed to one/several social identities; and discrimination attributed to most/all social identities. Experiencing general discrimination was associated with postpartum depression symptoms when compared to experiencing no discrimination among Black (9% vs. 5, p=0.04) and White participants (18% vs. 9%, p=0.01). White participants experiencing general discrimination gave birth to low birthweight infants at a higher rate than those experiencing no discrimination (6% vs. 11%, p=0.04). No significant subgroup differences were observed among Hispanic participants.

Conclusion: Perceived discrimination may play an influential role in shaping perinatal health. Further research integrating an intersectional lens to the study of discrimination and perinatal health outcomes is needed.

Keywords: intersectionality, discrimination, latent class analysis, health inequities, perinatal health, pregnancy

Summary Box:

What is known on this topic?

Discrimination is consistently associated with poor health outcomes and health disparities, including for perinatal health. Yet, few studies address intersectional discrimination.

What is added by this report?

We evaluate discrimination based on multiple social identities, identifying distinct subgroups of discrimination, and assessing differential association with adverse prenatal health outcomes.

Black and White participants exposed to general discrimination are more likely to experience symptoms of postpartum depression and White participants deliver more low birthweight infants relative to those who experience no discrimination.

What are the implications for public health practice?

Perceived discrimination in pregnancy can be associated with adverse perinatal health outcomes.

Addressing intersectional discrimination exposure may promote perinatal health.

Introduction

Racial and ethnic disparities in perinatal health are present across many countries but are particularly stark in the United States (US). Infants of Black pregnant people die at more than twice the rate of White, and Black pregnant people themselves are three times more likely to die during pregnancy.^{1,2} Perinatal health disparities are also seen by health insurance status, age, and

weight.^{2,3,4} One explanation for the origin of these disparities is the increased burden of stress associated with exposure to persistent discrimination experienced over the life course. A large and growing body of research demonstrates the negative impact of perceived discrimination on health,⁵ and suggests discrimination is an important risk factor for adverse perinatal health outcomes (APHOs) including preterm birth, low birthweight, small for gestational age and hypertensive disorders of pregnancy.⁶

Existing literature assessing the impact of discrimination on health has been limited by a focus on discrimination based on a single dimension, most commonly race-based discrimination.⁷ A focus exclusively on racial discrimination may mask important complexities in the maternal discrimination experience and potentially underestimates the overall impact of discrimination on perinatal health.⁸ Adopting an intersectionality framework recognizes that individuals simultaneously occupy multiple interconnected social identities (e.g., race, ethnicity, gender, sexual orientation, socioeconomic status) that confer privilege or disadvantage.^{9,10} Latent Class Analysis (LCA) offers one method to apply an intersectional approach in quantitative analysis.¹¹ LCA is a data driven method which probabilistically assigns individuals to latent subgroups based on observed categorical indicator variables.¹²

In the present study, we aim to first classify mutually exclusive subgroups of pregnant people based on patterns of response to Everyday Discrimination Scale (EDS) items through LCA and second to examine whether subgroups characterizing different patterns of discrimination are differentially associated with APHOs.

Methods

Participants, Design and Setting

We analyzed data from the Centering and Racial Disparities (CRADLE) study (ClinicalTrials.gov identifier: NCT02640638), a randomized controlled trial (RCT) of pregnant persons (n=2,348) conducted at a single obstetrics and gynecology practice in Greenville, South Carolina. The primary objective of the CRADLE study was to compare the rate of preterm birth (PTB) and low birthweight (LBW) of patients who participated in group prenatal care (a novel model of prenatal care combining clinical assessment, prenatal education, and peer socialization) to their counterparts in standard individual prenatal care, as well as racial disparities in these outcomes. The CRADLE study was approved by the Prisma Health institutional review board (Pro00043994). The full study protocol and primary findings have been published previously.^{13,14}

The study population was medically low risk pregnant persons of diverse race and ethnicities. Eligible patients were between 14 and 45 years of age, were less than 24 weeks gestational age at enrollment and were proficient in English or Spanish. Exclusion criteria included medical or pregnancy complications that would preclude prenatal care and delivery by a nurse practitioner or nurse midwife (e.g. pregestational diabetes mellitus, chronic hypertension requiring medication, any disease requiring immunosuppression, a body mass index of $>50\text{kg/m}^2$, multiple gestation, patients anticipating a planned preterm delivery or planned cerclage or lethal fetal anomalies) or patients with medical, social or behavioral conditions that would preclude participation in group care (e.g. active pulmonary tuberculosis, current incarceration, or severe uncontrolled psychiatric illness).

Data collection

Study recruitment took place between February 2016 and March 2020. Participants were followed from enrollment, through delivery and 12-weeks postpartum. Data was collected at

three time points: 1) the initial survey at the baseline visit at 8-23 weeks gestational age, 2) a second survey between 30-40 weeks gestational age, and 3) postpartum medical chart abstraction. Surveys included demographic questions and numerous psychosocial and behavioral measures. Medical and delivery information were collected through manual chart abstraction as well as automated query of the electronic medical record (EPIC Systems INC, Verona WI).

Measures

Discrimination indicator variables

Indicator variables used to define unobserved latent class membership were comprised of patient response to the adapted 11-item Everyday Discrimination Scale (EDS) administered at baseline.¹⁵ The EDS is one of the most commonly used measures of discrimination, and has been shown to have high reliability and construct validity.⁶ The EDS first asks respondents about their day-to-day experience of mistreatment. Response values are on a 4-point Likert scale ranging from never to often. Respondents who indicate any discrimination are then asked to identify the reasons for their mistreatment and are able to select multiple reasons including gender, race and ethnicity, insurance and Medicaid status, ancestry and national origin, age, religion, weight, some other aspect of physical appearance, sexual orientation, education and income. A binary variable of discrimination frequency was formed representing indication of never vs. rarely, sometimes, or often experiencing discrimination. Each attribution for discrimination was coded as a binary variable with possible responses of either yes or no. Attributions with low prevalence were combined to form an “other” discrimination variable.

Outcome Variables

The primary outcome was a composite measure of APHOs. A binary variable was created representing indication of none vs. one or more of the following seven outcomes: preterm birth

(PTB; delivery at <37 weeks of gestation), low birthweight (LBW; infant birthweight of <2500 g) small for gestational age (SGA; birthweight below the 10th percentile for gestational age), infant admission to the neonatal intensive care unit (NICU), 5-minute Apgar score <7, pre-eclampsia and patient admission to the intensive care unit (ICU). Individual APHOs composite components, as well as postpartum depression symptoms (PPDS) were considered as secondary outcomes. PPDS was identified based on Edinburgh Postnatal Depression Scale (EPDS) response.¹⁶ The EPDS is a widely used 10-item screening instrument for depression risk, which has shown high sensitivity and specificity in detecting depressive disorders with a cutoff of 13.¹⁷ The EPDS was routinely administered at the postpartum outpatient visit as part of routine clinical care and the results abstracted from the medical record. A binary PPDS variable representing EPDS scores of <13 vs. ≥ 13 was formed.

Sociodemographic Variables

Self-reported sociodemographic characteristics were collected through the baseline survey and included race and ethnicity (categorized as Black, Hispanic, White and “Other” race and ethnicity); age (categorized as 14-24, 25-34 and 35-45); Medicaid eligible (dichotomized as yes or no); educational attainment (categorized as less than high school, high school, more than high school); current relationship with baby’s father (categorized as married, engaged/in committed dating relationship or “other” relationship); nativity (dichotomized as born in the US vs. born outside the US); parity (dichotomized as nulliparous vs. primiparous/multiparous); and body mass index (BMI) at initial prenatal care visit (categorized as underweight (BMI <18.5), healthy weight (≥ 18.5 BMI <25), overweight (≥ 25 BMI <30) and obese (BMI ≥ 30)). Participants identified their race and ethnicity through questions used by the US Census Bureau, which

allowed participants to select multiple categories, as well as providing a space for open ended description of race and ethnicity.¹⁸

Statistical Analysis

All statistical analysis were performed in SAS (Version 9.4; SAS Institute, Inc, Cary, NC). First, sample characteristics were described and differences by race and ethnicity examined using X^2 tests. LCA Models were then estimated using SAS PROC LCA and the LCABootstrap Macro.^{19,20} To identify an optimal LCA model, models with between 1 and 6 latent classes were tested. Optimal models were indicated by minimum Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values in addition to the Bootstrap Likelihood Ratio Test (BLRT) which compares model fit for k classes relative to k+1 classes. Two primary sets of parameters are estimated: class membership probabilities (the size of the latent class identified) and item response probabilities (the conditional probability of a response given class membership). Item response probabilities were used to label latent classes. A likelihood ratio difference test was used to test equality across race and ethnicity groups following a three step approach, and race and ethnicity groups modeled separately.¹²

The Block, Croon and Hagenarrs (BCH) three-step approach was used to assess whether latent classes were associated with APHOs, applied separately for each outcome.²¹ Parameters of the LCA model are first estimated without distal outcomes, posterior probabilities of latent class membership are then used to compute a weighting variable and the association between the weighted variable and the distal outcome investigated using logistic regression. The %LCA_Distal_BCH macro provides an overall test of association between class membership and outcomes of interest, as well as pairwise comparisons of the expected values between classes using Wald tests.²¹ A p-value of <0.05 was considered significant.

Results

Descriptive Statistics

Of the 2,348 CRADLE study participants, 2.6% (n=62) participants were excluded from the current project due to missing values on all indicator variables for a final analytic sample of 2286. Over 40% of the sample identified as Black, 20.6% as Hispanic, 37.3% as White and 1.3% as “other” race/ethnicity (Table 1). The majority of participants were between 25-35 years of age (76.8%), Medicaid eligible (96.4%), had a high school education (54.7%), were engaged or in a committed relationship with the baby’s father (51.1%), had previously given birth (55.5%), were born in the US (84.3%) and were in overweight or obese BMI category (64.3%). The frequency of these sociodemographic characteristics significantly differed across race and ethnic groups ($p<0.001$).

Measures of Discrimination

Half of participants (51.1%) reported experiencing discrimination rarely, sometimes, or often (Table 1). Many participants attributed discrimination to age (15.1%) followed by race or ethnicity (14.2%), weight or physical appearance (11.6%), gender (11.3%), education or income (9.9%) and other characteristics (6.5%). Apart from attribution to the combined “other” characteristics variable, participant reports of discrimination significantly differed by race and ethnicity ($p<0.001$). Fewer Hispanic participants (42.7%) reported experience of discrimination relative to Black (51.6%) and White (54.9%). White participants were least likely to attribute discrimination to race or ethnicity (4.3%), while Hispanic participants were least likely to make other attributions (5.7-6.6%).

Overall, 31.9% of the sample had an APHO (Table 1). Black participants had a higher rate APHOs (38.3%, n=357), relative to Hispanic (24.8%, n=117) and White (29.5%, n=252).

Prevalence of individual outcomes ranged from less than 1% for ICU admission to 17.5% for small for gestational age. White participants (14.4%) had higher rates of PPDS than Black (7.7%) and Hispanic (5.8%). It should be noted that due to collection at the postpartum visit, missingness on the PPDS variable was considerably higher than for other outcome variables, missing from 31.5% of participants (n=719).

Latent Class Models

Fit indices for models ranging from 1 to 6 classes are presented in Table 2. Classes 1-4 were well identified (higher % of seeds associated). Entropy for models ranged between 1-0.85, suggesting low classification uncertainty. The BIC suggests a 3-class model, while the AIC suggests a 4-class model offers the best fit. The 4-class model was supported by the BLRT and yielded interpretable and meaningful classes; it was therefore selected to offer the best fit. Table 3 displays the latent class profiles and labels for the 4-class model. Sociodemographic characteristics across the 4 classes are available in supplemental material.

The likelihood-ratio difference test revealed that underlying LCA measurements significantly differed across racial and ethnic groups ($\Delta G^2 = 100.7$, $df = 56$, $p < 0.001$). Thus, race and ethnicity specific latent class models were estimated. Participants reporting “other” race and ethnicity were excluded from stratified LCA due to the small sample size. Fit indices and modal interpretability for each racial and ethnic were examined individually. Models with 1-5 classes were well identified for Black and White participants and with 1-4 classes for Hispanic participants. Minimum AIC and BIC indicated the best fitting model for Black and White participants to be 3 or 4 classes and for Hispanic participants to be 2, 3 or 4 classes. The BLRT suggested models with up to 4 classes offered superior fit for Black and Hispanic participants and up to 3 classes White. Model selection criteria largely indicated at 3 or 4 class model as optimal,

the interpretability of models were evaluated and a 4-class model selected as the best fit for each race and ethnicity group (Table 2).

Race and Ethnicity Stratified Models

Similar and different latent classes emerged in race and ethnicity stratified models (Table 3).

Among all race and ethnicity groups the largest class (45.6%-59.2%) labelled “No Discrimination” did not experience discrimination. The second largest class for each race/ethnicity (31%-41.5%), labelled “General Discrimination” experienced discrimination yet had a relatively low probability of attributing discrimination to any particular characteristic. Uniquely among Hispanic participants the “General Discrimination” class had a moderate probability of attributing discrimination to race and ethnicity.

The two smaller classes of maternal discrimination in each race and ethnicity varied. Among Black participants, the third largest class (12.5%) labelled “Gender, Race and Ethnicity and Age Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to gender, race and ethnicity, and age but a low probability of attributing discrimination to other characteristics. The fourth and smallest class (5.6%), labelled “Compound Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to all characteristics.

Among Hispanic participants, the third largest class (6.1%) labelled “Other Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to characteristics in the other discrimination category. The fourth and smallest class (3.6%), labelled “Compound Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to all characteristics except age and weight/appearance for which they had a moderate probability.

Among the White sample, the third largest class (7%) labelled “Education/Income, Weight/Appearance and Age Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to education/income, weight/appearance and age but a low probability of attributing discrimination to other characteristics. The fourth and smallest class (5.8%), labelled “Compound Discrimination” experienced discrimination and had a relatively high probability of attributing discrimination to gender, age, and weight/appearance, as well as a moderate probability of attributing discrimination to other characteristics.

Association with Adverse Perinatal Health Outcomes

Estimated outcome probability for each latent class and pairwise comparisons between each latent class are displayed in Table 4 and 5 respectively. Our focus will be on results of the race and ethnicity stratified models as they were determined to best fit the data.

Among Black participants, pairwise comparisons indicate the expected probability of severe/moderate PPDS were significantly higher for the “General Discrimination” class relative to the “No Discrimination” class ($P=0.09$ vs. $P=0.05$; $p=0.04$). No other significant latent class differences were identified in the Black sample. Among Hispanic participants, pairwise comparisons did not uncover any significant between class differences in outcomes that were able to be compared. Among White participants, pairwise comparisons indicated the expected probability of severe/moderate PPDS for the “General Discrimination” class was significantly higher than for the “No Discrimination class” ($P=0.18$ vs. $P=0.09$; $p=0.01$). Additionally, the probability of LBW for the “General Discrimination” class was significantly higher than for the “No Discrimination class” ($P=0.11$ vs. $P=0.06$; $p=0.04$). Finally, among White participants, expected probability of composite APHO was significantly lower for the “Compound

Discrimination” class than the “General discrimination class ($P=0.12$ vs. $P=0.35$; $p=0.02$). No further significant differences in outcomes by class were observed in the White sample.

Discussion

Guided by an intersectionality framework, we explored pregnant persons varied and intersecting exposure to discrimination and the impact on birth outcomes. Discrimination varied significantly across race and ethnicity therefore, models were estimated separately for each race and ethnicity. We identified four unique classes of perceived discrimination. The largest two subgroups of discrimination across each race and ethnicity included participants who reported never experiencing discrimination (No discrimination) and participants who experienced discrimination but did not strongly attribute discrimination to any one characteristic (general discrimination). The smaller two subgroups varied across racial and ethnicity groups but included one class with a high probability of attributing discrimination to a single or multiple characteristics and one class with a high or moderate probability of attributing discrimination to most or all characteristics. Discrimination subgroups identified are consistent with previous studies of intersectional discrimination, which have largely taken place among older adults.^{22–24} In which, similar classes of no/minimal discrimination, single/general attribution, several/multiple attributions, and high/all attributions were identified.

Further, we found pregnant persons’ risk of developing some APHOs significantly differed by discrimination subgroup. Black and White participants experiencing general discrimination were found to be at an increased risk of PPDS relative to participants who did not experience discrimination. This finding is congruent with existing literature demonstrating an association between discrimination and PPDS. Analysis of the Pregnancy Risk Assessment

Monitoring System (PRAMS) postnatal survey suggests that respondents who report being upset by race-based discrimination in the prior year are more likely to identify as experiencing PPDS, with the strongest relationship seen for Black participants.²⁵⁻²⁷ Analysis of the overall sample produced conflicting findings, with those in the general discrimination subgroup found to have a significantly lower rate of PPDS relative to the no discrimination, as well as the education and income discrimination subgroups. However, race and ethnicity stratified models were determined to better fit the data as the null hypothesis of invariance across groups did not hold, suggesting the meaning of the four estimated classes differed by race and ethnicity.

Contrary to previous studies,^{25,26,27} our analysis did not uncover an association between maternal discrimination and PPDS among Hispanic participants. Lack of association between discrimination subgroups and outcomes may be due to the small sample size of Hispanic participants in our study relative to other race and ethnic groups. Among Hispanic participants, class associations were only examined for composite APHOs, PTB and APGAR score as the sample size was too small to achieve accurate estimates for other outcome variables. A pattern in class probabilities is not apparent, though not significantly different the “No discrimination” class had the highest probability of experiencing composite APHOs, the “Other discrimination” class of PTB and the “Compound discrimination” class of an APGAR score of less than seven at five minutes. Finding could reflect protective factors buffering against the effect of discrimination within this community. Relative to other race and ethnic groups, Hispanic participants had lower rates on all outcomes measured. This pattern has been noted previously in the literature and is coined the “Hispanic Paradox”.²⁸ Despite lower socioeconomic status, Hispanic persons defy the socioeconomic gradient of health demonstrating relatively good health outcomes. It is hypothesized that sociocultural norms and values such as social support and

religiosity may buffer Hispanic persons against health disparities.²⁹ Studies suggest the Hispanic paradox deteriorates with increased time in the United States, as well as among subsequent generations.³⁰ The majority of Hispanic participants in our sample (65.6%) were born outside the United States.

Among White participants, those who experienced general discrimination also had a higher risk of delivering a LBW infant relative to participants who did not experience discrimination. Although this is consistent with extant literature supporting the association between perceived discrimination and risk of APHOs, that is was observed only among White participants is surprising, as the relationship has previously been seen to be most robust among Black pregnant persons.⁶ White participants reported the highest rate of discrimination in our sample. We incorporated assessment of discrimination based on multiple social identities therefore, findings may be due to the high prevalence of discrimination based on social identities other than race and ethnicity among White participants. White participants were most likely to attribute their discrimination to age and had a larger subset of participants under 25 years old than other racial and ethnic groups. Data collection took place during the Trump administration in a southern predominately conservative republican leaning area. Studies of perceived racial relations in the US suggest, White Americans perceive decreases in anti-black bias to be accompanied by increasing anti-white bias or “reverse racism” and conservative White Americans believe anti-white bias is now more prominent the anti-black bias.³¹ Findings might reflect perceptions of this tension or could be a function of measure interpretation. While numerous studies attest the EDS strong psychometric properties, recent studies raise concerns about the instruments equivalence across diverse social groups.³² Interpretation of EDS

questions may differ across racial groups, with White participants more likely to interpret the scale as asking about unfair treatment rather than specifically about discrimination.³³

An additional unexpected finding of our analysis was that White participants experiencing compound discrimination were less likely to experience an APHO relative to those experiencing general discrimination. This is the opposite relationship than would be predicted by an intersectionality framework and paired with other findings could suggest unique risks among the general discrimination subgroups. Among White participants, those experiencing general discrimination had the highest probability of experiencing most APHOs. By contrast, among black participants, those experiencing compound discrimination had the highest probability of experiencing most APHOs. These findings might be in keeping with an interpretation of EDS items as querying general unfair behavior rather than discrimination among White participants.³³ Alternatively, this finding may be an artifact of the compound discrimination subgroups small class size.

Limitations

Our study has limitations. First, while our sample is relatively large, sub-analyses by race and ethnicity further subdivides the sample limiting power to detect differences in low prevalence outcomes. For this reason, discrimination subgroups representing discrimination attributed to one, many or all characteristics may not have been significantly associated with greater risk of APHOs in our sample. Second, the present sample included pregnant persons with low medical risk from a single practice site, findings may therefore not be generalizable to other populations. Moreover, our focus on medically low risk pregnancies may have resulted in attenuated associations, particularly among Black persons who might be expected to have worsened health at entry to prenatal care due to disadvantages across the life course. Third, we utilized a

composite measure of APHOs as our primary outcome to increase our power and communicate the net effect of discrimination experiences on perinatal health. However composite measures also present challenges to interpretation, particularly when components differ in patient importance, event rate and effect size.³⁴ In accordance with recommendations,³⁵ individual components were reported alongside the composite measure. Finally, at this time the BCH distal outcome procedure in SAS is not equipped to accommodate covariates, our findings therefore do not control for other potentially confounding factors. While other strategies for distal outcome analysis can accommodate covariates in SAS, the BCH approach has been found to be more accurate than alternatives (e.g. classify and analyze approach, inclusive classify-analyze approach and pseudo pulls approach), taking into account uncertainty in class assignment.^{36, 37}

Strengths

Our study also has several strengths. First, we applied a novel statistical approach, LCA, to explore experiences of discrimination during pregnancy. LCA moves beyond a single status analysis, providing a more comprehensive assessment of discrimination during pregnancy and its association with APHOs. The person-centered nature of LCA supports the application of an intersectional approach in which multiple social identities are jointly considered. Second, our study population which included a diverse racial and ethnic study population with primarily low-income participants. Finally, we had rigorous data collection including variables from patient self-reported validated measures and through medical chart abstraction.

Implications

This study enhances our understanding of discrimination in pregnancy and associated perinatal health outcomes which may inform strategies for perinatal health promotion. Findings highlight the importance of assessing and addressing discrimination as intersectional rather than

unidimensional domains. Interventions adopting an intersectionality framework may be best suited to respond to the complex discrimination experiences that impact pregnant people and promote perinatal health. Screening for discrimination exposure as a significant risk factor for adverse perinatal health could be incorporated in prenatal care setting and a systematic surveillance system of discrimination exposure and perinatal outcomes implemented.

Conclusion

Our results align with existing evidence on perceived discrimination as an important risk factor for APHOs. By incorporating an intersectionality framework this study extends understanding of the variety and intersections of discrimination experienced by pregnant persons, as well as the association with APHOs, particularly PPDS. Future research in large samples is needed to further clarify subgroups most at risk, as well as potential moderating factors. This work will be facilitated by the modification and validation of instruments to assess perceived discrimination for use across diverse social groups.

References

1. Hoyert, D. *Maternal Mortality Rates in the United States, 2020*. <https://stacks.cdc.gov/view/cdc/113967> (2022) doi:10.15620/cdc:113967.
2. Ely, D. M. & Driscoll, A. K. Infant Mortality in the United States, 2020: Data From the Period Linked Birth/Infant Death File. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **71**, 1–18 (2022).
3. Kim, H.-J., Min, K.-B., Jung, Y.-J. & Min, J.-Y. Disparities in infant mortality by payment source for delivery in the United States. *Prev. Med.* **145**, 106361 (2021).
4. Ely, D. M., Gregory, E. C. W. & Drake, P. Infant Mortality by Maternal Prepregnancy Body Mass Index: United States, 2017-2018. *Natl. Vital Stat. Rep. Cent. Dis. Control Prev. Natl. Cent. Health Stat. Natl. Vital Stat. Syst.* **69**, 1–11 (2020).
5. Williams, D. R., Lawrence, J. A., Davis, B. A. & Vu, C. Understanding how discrimination can affect health. *Health Serv. Res.* **54**, 1374–1388 (2019).
6. van Daalen, K. R. *et al.* Racial discrimination and adverse pregnancy outcomes: a systematic review and meta-analysis. *BMJ Glob. Health* **7**, e009227 (2022).
7. Lewis, T. T., Cogburn, C. D. & Williams, D. R. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. *Annu. Rev. Clin. Psychol.* **11**, 407–440 (2015).
8. Lewis, T. T. & Van Dyke, M. E. Discrimination and the Health of African Americans: The Potential Importance of Intersectionalities. *Curr. Dir. Psychol. Sci.* **27**, 176–182 (2018).
9. Else-Quest, N. M., French, A. M. & Telfer, N. A. The intersectionality imperative: Calling in stigma and health research. *Stigma Health* (2022) doi:10.1037/sah0000397.
10. Crenshaw, K. Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory, and Antiracist Politics. in *Living with Contradictions* (ed. Jaggar, A. M.) 39–52 (Routledge, 2018). doi:10.4324/9780429499142-5.
11. Else-Quest, N. M. & Hyde, J. S. Intersectionality in Quantitative Psychological Research: II. Methods and Techniques. *Psychol. Women Q.* **40**, 319–336 (2016).
12. Lanza, S. T., Collins, L. M., Lemmon, D. R. & Schafer, J. L. PROC LCA: A SAS Procedure for Latent Class Analysis. *Struct. Equ. Model. Multidiscip. J.* **14**, 671–694 (2007).
13. Crockett, A. H. *et al.* Group versus traditional prenatal care for improving racial equity in preterm birth and low birthweight: the Cradle randomized clinical trial study [Manuscript submitted for publication]. (2022).

14. Chen, L. *et al.* Centering and Racial Disparities (CRADLE study): rationale and design of a randomized controlled trial of centeringpregnancy and birth outcomes. *BMC Pregnancy Childbirth* **17**, 118 (2017).
15. Williams, D. R., Yan Yu, Jackson, J. S. & Anderson, N. B. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *J. Health Psychol.* **2**, 335–351 (1997).
16. Cox, J. L., Holden, J. M. & Sagovsky, R. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br. J. Psychiatry J. Ment. Sci.* **150**, 782–786 (1987).
17. O'Connor, E., Rossom, R. C., Henninger, M., Groom, H. C. & Burda, B. U. Primary Care Screening for and Treatment of Depression in Pregnant and Postpartum Women: Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* **315**, 388 (2016).
18. Wallman, K. K. & Hodgdon, J. Race and ethnic standards for Federal statistics and administrative reporting. *Stat. Report. Off. Fed. Stat. Policy Stand.* 450–454 (1977).
19. Dziak, J. J. & Lanza, S. T. *LcaBootstrap SAS Macro Users' Guide (Version 4.0)*. (University Park: The Methodology Center, Penn State, 2016).
20. Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A. & Collins, L. M. *PROC LCA & PROC LTA Users' Guide Version 1.3.2*. (University Park: The Methodology Center, Penn State, 2015).
21. Dziak, J. J., Bray, B. & Wagner, A. *LCA_Distal_BCH SAS Macro Users' Guide (Version 1.1)*. (The Methodology Center, Penn State, 2017).
22. Lu, P., Kong, D., Shelley, M. & Davitt, J. K. Intersectional Discrimination Attributions and Health Outcomes Among American Older Adults: A Latent Class Analysis. *Int. J. Aging Hum. Dev.* **95**, 267–285 (2022).
23. Earnshaw, V. A. *et al.* Intersectional experiences of discrimination in a low-resource urban community: An exploratory latent class analysis. *J. Community Appl. Soc. Psychol.* **28**, 80–93 (2018).
24. Erving, C. L., Cobb, R. J. & Sheehan, C. Attributions for Everyday Discrimination and All-Cause Mortality Risk Among Older Black Women: A Latent Class Analysis Approach. *The Gerontologist* gnac080 (2022) doi:10.1093/geront/gnac080.
25. Bossick, A. S. *et al.* Experiences of racism and postpartum depression symptoms, care-seeking, and diagnosis. *Arch. Womens Ment. Health* **25**, 717–727 (2022).

26. Segre, L. S., Mehner, B. T. & Brock, R. L. Perceived Racial Discrimination and Depressed Mood in Perinatal Women: An Extension of the Domain Specific Stress Index. *Womens Health Issues* **31**, 254–262 (2021).
27. Weeks, F., Zapata, J., Rohan, A. & Green, T. Are Experiences of Racial Discrimination Associated with Postpartum Depressive Symptoms? A Multistate Analysis of Pregnancy Risk Assessment Monitoring System Data. *J. Womens Health* **31**, 158–166 (2022).
28. Singh, G. K. & Siahpush, M. Ethnic-Immigrant Differentials in Health Behaviors, Morbidity, and Cause-Specific Mortality in the United States: An Analysis of Two National Data Bases. *Hum. Biol.* **74**, 83–109 (2002).
29. Mickelson, K. D. *et al.* Role of discrimination and resilience on birth weight: A systematic examination in a sample of Black, Latina, and White women. *Womens Health* **18**, 174550572210939 (2022).
30. Giuntella, O. The Hispanic health paradox: New evidence from longitudinal data on second and third-generation birth outcomes. *SSM - Popul. Health* **2**, 84–89 (2016).
31. Rasmussen, R. *et al.* White (but Not Black) Americans Continue to See Racism as a Zero-Sum Game; White Conservatives (but Not Moderates or Liberals) See Themselves as Losing. *Perspect. Psychol. Sci.* **17**, 1800–1810 (2022).
32. Bastos, J. L. & Harnois, C. E. Does the Everyday Discrimination Scale generate meaningful cross-group estimates? A psychometric evaluation. *Soc. Sci. Med.* **265**, 113321 (2020).
33. Harnois, C. E. What do we measure when we measure perceptions of everyday discrimination? *Soc. Sci. Med.* **292**, 114609 (2022).
34. Sherman, L. E. & Greenfield, P. M. Forging friendship, soliciting support: A mixed-method examination of message boards for pregnant teens and teen mothers. *Comput. Hum. Behav.* **29**, 75–85 (2013).
35. Lai, N. M. *et al.* Use of Composite Outcomes in Neonatal Trials: An Analysis of the Cochrane Reviews. *Neonatology* **118**, 259–263 (2021).
36. Dziak, J. J., Bray, B. C., Zhang, J., Zhang, M. & Lanza, S. T. Comparing the Performance of Improved Classify-Analyze Approaches for Distal Outcomes in Latent Profile Analysis. *Methodology* **12**, 107–116 (2016).
37. Bakk, Z. & Vermunt, J. K. Robustness of Stepwise Latent Class Modeling With Continuous Distal Outcomes. *Struct. Equ. Model. Multidiscip. J.* **23**, 20–31 (2016).

Tables and Figures

Table 4.1 Frequency of sociodemographic characteristics, everyday discrimination and adverse perinatal health outcomes

	Frequency (%)				P value
	A. Overall n=2286	B. Black	C. Hispanic	D. White	
Sociodemographic Characteristics					
Race and ethnicity					
Black	933 (40.8%)	-	-	-	
Hispanic	471 (20.6%)	-	-	-	
White	853 (37.3%)	-	-	-	
“other” race	29 (1.3%)	-	-	-	
Age					
14-24	401 (17.5%)	155 (16.6%)	74 (15.7%)	170 (19.9%)	<0.0001
25-34	1755 (76.8%)	740 (79.3%)	343 (72.8%)	649 (76.1%)	
35-45	130 (5.7%)	38 (4.1%)	54 (11.5%)	34 (3.9%)	
Medicaid eligibility					
Eligible	1970 (96.4%)	795 (96.9%)	417 (96.1%)	734 (96.2%)	0.6330
Ineligible	73 (3.6%)	25 (3.1%)	17 (3.9%)	29 (3.8%)	
Educational Attainment					
Less than high school	556 (24.3%)	150 (16.1%)	169 (35.9%)	232 (27.2%)	<0.0001
High school	1226 (53.6%)	562 (60.2%)	202 (42.9%)	446 (52.3%)	
More than high school	460 (20.1%)	203 (21.8%)	87 (18.5%)	162 (18.9%)	
Missing	44 (1.9%)	18 (1.9%)	13 (2.8%)	13 (1.5%)	
Relationship status					
Married	422 (18.5%)	261 (27.9%)	52 (11.0%)	137 (16.1%)	<0.0001
Engaged or committed dating relationship	913 (39.9%)	59 (6.3%)	171 (36.3%)	180 (21.1%)	
Single or other	451 (19.7%)	374 (40.1%)	176 (37.4%)	352 (41.3%)	
Missing	500 (21.9%)	239 (25.6%)	72 (15.3%)	184 (21.6%)	
Nativity					
Born outside the US	358 (15.7%)	23 (2.5%)	309 (65.6%)	13 (1.5%)	<0.0001
Born in the US	1917 (83.9%)	910 (97.5%)	154 (32.7%)	838 (98.2%)	
Missing	11 (0.5%)	0 (0%)	8 (1.7%)	2 (0.2%)	
Initial BMI					
Underweight	72 (1.2%)	36 (3.9%)	8 (1.7%)	28 (3.3%)	<0.0001
Healthy weight	744 (32.6%)	300 (32.2%)	136 (28.9%)	301 (35.3%)	
Overweight	577 (25.2%)	206 (22.1%)	155 (32.9%)	207 (24.3%)	
Obese	893 (39.1%)	391 (41.9%)	172 (36.5%)	317 (37.2%)	
Parity					
Nulliparous	1018 (44.5%)	445 (47.7%)	170 (36.1%)	391 (45.8%)	<0.0001
Primiparous or Multiparous	1268 (55.5%)	488 (52.3%)	301 (63.9%)	462 (54.2%)	
Indicator Variables					
Frequency of Discrimination					
Never	1117 (48.9%)	452 (48.5%)	270 (57.3%)	384 (45.0%)	<.0001
Rarely, sometimes, or often	1169 (51.1%)	481 (51.6%)	201 (42.7%)	469 (54.9%)	
Discrimination Attribution					
Age	344 (15.1%)	156 (16.7%)	27 (5.7%)	157 (18.4%)	<.0001
Race/ethnicity	325 (14.2%)	189 (20.3%)	89 (18.9%)	37 (4.3%)	<.0001
Weight and some other aspect of physical appearance	266 (11.6%)	113 (12.1%)	27 (5.7%)	120 (14.1%)	<.0001
Gender	259 (11.3%)	146 (15.7%)	28 (5.9%)	80 (9.4%)	<.0001

Education or income level	228 (9.9%)	98 (10.5%)	26 (5.5%)	102 (11.9%)	0.0008
Other	148 (6.5%)	65 (6.9%)	31 (6.6%)	47 (5.5%)	0.4373
Outcome Variables					
Composite APHOs					
None	1555 (68.0%)	576 (61.7%)	354 (75.2%)	601 (70.5%)	<.0001
Any	731 (31.9%)	357 (38.3%)	117 (24.8%)	252 (29.5%)	
PTB					
No	1954 (90.5%)	784 (89.2%)	412 (92.2%)	732 (90.7%)	0.2045
Yes	205 (9.5%)	95 (10.8%)	35 (7.8%)	75 (9.3%)	
Missing	127	54	24	46	
LBW					
No	1828 (90.8%)	702 (87.6%)	410 (93.6%)	691 (92.3%)	0.0004
Yes	186 (9.2%)	99 (12.4%)	28 (6.4%)	58 (7.7%)	
Missing	272	132	33	104	
SGA					
No	1660 (82.5%)	602 (75.3%)	394 (89.5%)	644 (85.9%)	<.0001
Yes	353 (17.5%)	198 (24.8%)	46 (10.5%)	105 (14.0%)	
Missing	273	133	33	104	
NICU admission					
No	1848 (97.9%)	738 (97.9%)	402 (99.3%)	683 (97.3%)	0.0820
Yes	38 (2.0%)	16 (2.1%)	3 (0.7%)	19 (2.7%)	
Missing	400	179	66	151	
Apgar < 7					
No	2051 (93.3%)	818 (91.6%)	436 (95.2%)	772 (93.9%)	0.0276
Yes	148 (6.7%)	75 (8.4%)	22 (4.8%)	50 (6.1%)	
Missing	87	40	13	31	
Preeclampsia					
No	2117 (92.6%)	856 (91.8%)	442 (93.8%)	791 (92.7%)	0.3576
Yes	169 (7.4%)	77 (8.3%)	29 (6.2%)	62 (7.3%)	
ICU					
No	2280 (99.7%)	931 (99.8%)	470 (99.8%)	850 (99.7%)	0.8264
Yes	6 (0.3%)	2(0.2%)	1(0.2%)	3(0.4%)	
PPDS					
Score <13	1413 (90.2%)	586 (92.3%)	324 (94.2%)	486 (85.6%)	<.0001
Score ≥13	154 (9.8%)	49 (7.7%)	20 (5.8%)	82 (14.4%)	
Missing	719	298	127	285	

Significant p-values bolded; P-values determined by X² test

Abbreviations: US, United States; BMI, Body Mass Index; APHOs, adverse perinatal health outcomes; LBW, low birth weight; PTB, preterm birth; SGA, small for gestational age; PPD, postpartum depression
Other discrimination includes discrimination attributed to insurance/Medicaid status, ancestry/national origin, sexual orientation or religion

Table 4.2 Fit indices for latent classes of discrimination in the overall sample and among Black, Hispanic and White

	Model	G ²	df	AIC	BIC	CAIC	SABIC	BLRT	Entropy	% of seeds associated
A. Overall	1-class	2724.45	120	2738.4	2778.6	2785.6	2756.36	n/a	1.00	100%
				5	0	0				
	2-class	308.26	112	338.26	424.28	439.28	376.62	0.01	0.85	100%
	3-class	131.43	104	177.43	309.33	332.33	263.25	0.01	0.88	99.00%
	4-class	84.55	96	146.55	324.32	355.32	225.82	0.01	0.85	34.00%
	5-class	60.81	88	138.81	362.46	401.46	238.55	0.02	0.88	3.7%
	6-class	45.02	80	139.02	408.55	455.55	259.22	0.1	0.80	5.40%
B. Black	1-class	1407.69	120	1407.6	1421.6	1462.5	1433.33	n/a	1.00	100%
				9	9	6				
	2-class	201.49	112	231.49	231.49	304.06	319.06	0.01	0.89	100%
	3-class	89.58	104	135.58	269.86	269.86	173.81	0.01	0.87	100%
	4-class	60.57	96	122.57	272.56	303.56	174.11	0.01	0.90	34.70%
	5-class	45.42	88	123.42	312.12	351.12	188.25	0.12	0.92	46.70%
	6-class	38.08	80	132.08	359.49	406.49	210.22	0.79	0.89	3.50%
C. Hispanic	1-class	514.03	120	514.03	528.03	557.11	564.11	n/a	1.00	100%
	2-class	78.89	112	108.89	171.21	186.21	123.61	0.01	0.86	100%
	3-class	50.70	104	96.70	192.26	215.26	119.26	0.01	0.93	96.60%
	4-class	33.51	96	95.51	224.31	255.31	125.92	0.04	0.89	50.40%
	5-class	22.39	88	100.39	262.43	301.43	138.65	0.19	0.91	11.30%
	6-class	16.17	80	110.17	305.45	352.45	156.28	0.62	0.86	13.70%
D. White	1-class	881.57	120	895.57	928.81	935.81	906.58	n/a	1.00	100%
	2-class	123.48	112	153.48	224.71	239.71	177.07	0.01	0.81	100%
	3-class	69.32	104	115.32	224.54	247.54	151.50	0.01	0.83	100%
	4-class	50.73	96	112.73	259.94	290.94	161.49	0.06	0.86	44.90%
	5-class	39.63	88	117.63	302.83	341.83	178.98	0.33	0.84	61.50%
	6-class	34.56	80	128.56	351.75	398.75	202.49	0.98	0.87	0.30%

Bolded letters indicated the best fitting models.

Abbreviations: G², Goodness of Fit test; df, degrees of freedom; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; CAIC, Consistent AIC; SABIC, sample size adjusted BIC, BLRT, Bootstrap Likelihood Ratio Test

Table 4.3 Item-response probabilities for four-class models of discrimination

Indicator items		Item response probabilities			
A.		Class 1: No discrimination (49.1%)	Class 2: General discrimination (32.3%)	Class 3: Education and income discrimination (8.8%)	Class 4: Gender, race, ethnicity and age discrimination (9.8%)
Overall					
	Discrimination frequency	0.00	0.99	0.99	0.99
	Gender	0.00	0.09	0.00	0.83
	Race and ethnicity	0.00	0.21	0.11	0.64
	Age	0.00	0.17	0.31	0.67
	Education and income	0.00	0.02	0.66	0.34
	Weight and appearance	0.00	0.16	0.33	0.37
	Other discrimination	0.00	0.05	0.19	0.31
B.		Class 1: No discrimination (48.9%)	Class 2: General discrimination (32.9%)	Class 3: Gender, race, ethnicity and age discrimination (12.5%)	Class 4: Compound discrimination (5.6%)
Black					
	Discrimination frequency	0.01	0.99	0.99	0.99
	Gender	0.00	0.00	0.91	0.71
	Race and ethnicity	0.00	0.24	0.61	0.82
	Age	0.00	0.17	0.54	0.79
	Education and income	0.00	0.17	0.07	0.69
	Weight and appearance	0.00	0.20	0.21	0.50
	Other discrimination	0.00	0.08	0.12	0.49
C.		Class 1: No discrimination (59.2%)	Class 2: General discrimination (31.0%)	Class 3: Other discrimination (6.1%)	Class 4: Compound Discrimination (3.6%)
Hispanic					
	Discrimination frequency	0.03	0.99	0.99	0.99
	Gender	0.00	0.09	0.00	0.78
	Race and ethnicity	0.00	0.45	0.22	0.91
	Age	0.00	0.11	0.09	0.41
	Education and income	0.00	0.06	0.26	0.54
	Weight and appearance	0.00	0.14	0.00	0.34
	Other discrimination	0.00	0.00	0.76	0.55
D.		Class 1: No discrimination (45.6%)	Class 2: General discrimination (41.5%)	Class 3: Education, income, weight, appearance and age discrimination (7.0%)	Class 4: Compound Discrimination (5.8%)
White					
	Discrimination frequency	0.01	0.99	0.99	0.99
	Gender	0.00	0.09	0.00	0.90
	Race and ethnicity	0.00	0.04	0.05	0.34
	Age	0.00	0.24	0.49	0.82
	Education and income	0.00	0.12	0.67	0.38
	Weight and appearance	0.00	0.16	0.62	0.49
	Other discrimination	0.00	0.04	0.24	0.39

Probabilities of 0.49 or higher are bolded.

Other discrimination includes attributions to insurance/Medicaid status, ancestry/national origin, sexual orientation and religion.

Table 4.4 Estimated proportions of adverse perinatal health outcomes by latent class

		BCH-Estimated Probabilities (95% CI)				
A.	n=2286	Class 1: No discrimination	Class 2: General discrimination	Class 3: Education and income Discrimination	Class 4: Gender, race, ethnicity and age discrimination	
Overall						
	APHOs	731 (31.9%)	0.32 (0.29-0.35)	0.33 (0.29-0.37)	0.31 (0.22-0.39)	0.31 (0.24-0.39)
	PTB	205 (9.5%)	0.09 (0.08-0.11)	0.12 (0.09-0.15)	0.04 (0.02-0.12)	0.09 (0.05-0.15)
	LBW	186 (9.2%)	0.08 (0.07-0.10)	0.09 (0.07-0.12)	0.10 (0.04-0.16)	0.11 (0.06-0.16)
	SGA	353 (17.5%)	0.17 (0.15-0.19)	0.17 (0.13-0.20)	0.21 (0.13-0.29)	0.18 (0.12-0.25)
	NICU	38 (2.0%)	0.02 (0.01-0.03)	0.02 (0.01-0.04)	0.01 (0.00-0.08)	0.02 (0.01-0.07)
	Apgar <7	148 (6.7%)	0.06 (0.05-0.08)	0.07 (0.05-0.09)	0.09 (0.04-0.14)	0.07 (0.03-0.12)
	Preeclam- -psia	169 (7.4%)	0.07 (0.06-0.09)	0.08 (0.06-0.10)	0.04 (0.01-0.10)	0.09 (0.06-0.15)
	PPDS	154 (9.8%)	0.21 (0.12-0.29)	0.06 (0.05-0.08)	0.12 (0.09-0.15)	0.10 (0.05-0.16)
B.	n=933	Class 1: No discrimination	Class 2: General discrimination	Class 3: Gender, race, ethnicity and age discrimination	Class 4: Compound discrimination	
Black						
	APHOs	357 (38.3%)	0.38 (0.33-0.42)	0.37 (0.31-0.43)	0.41 (0.30-0.51)	0.43 (0.25-0.62)
	PTB	95 (10.8%)	0.10 (0.07-0.13)	0.11 (0.07-0.15)	0.09 (0.02-0.15)	0.17 (0.03-0.31)
	LBW	99 (12.4%)	0.11 (0.08-0.14)	0.13 (0.09-0.18)	0.12 (0.06-0.22)	0.22 (0.09-0.42)
	SGA	198 (24.8%)	0.23 (0.19-0.28)	0.26 (0.20-0.31)	0.25 (0.17-0.37)	0.34 (0.18-0.55)
	NICU	16 (2.1%)	0.02 (0.01-0.04)	0.02 (0.01-0.05)	0.03 (0.01-0.11)	0.06 (0.01-0.26)
	Apgar <7	75 (8.4%)	0.08 (0.05-0.11)	0.09 (0.06-0.13)	0.11 (0.06-0.19)	0.06 (0.01-0.29)
	Preeclam- -psia	77 (8.25%)	0.08 (0.06-0.11)	0.08 (0.05-0.12)	0.13 (0.05-0.18)	0.06 (0.01-0.26)
	PPDS	49 (7.7%)	0.05 (0.03-0.08)	0.09 (0.06-0.15)	0.09 (0.04-0.20)	0.13 (0.04-0.38)
C.	n=471	Class 1: No discrimination	Class 2: General discrimination	Class 3: Other discrimination	Class 4: Compound discrimination	
Hispanic						
	APHOs	117 (24.8%)	0.27 (0.22-0.33)	0.21 (0.15-0.29)	0.23 (0.09-0.46)	0.21 (0.06-0.54)
	PTB	35 (7.8%)	0.07 (0.05-0.11)	0.07 (0.04-0.14)	0.15 (0.05-0.39)	0.07 (0.01-0.47)
	Apgar <7	22 (4.8%)	0.05 (0.03-0.08)	0.02 (0.00-0.09)	0.14 (0.04-0.36)	0.15 (0.04-0.47)
D.	n=853	Class 1: No Discrimination	Class 2: General discrimination	Class 3: Education, income, weight, appearance, age discrimination	Class 4: Compound Discrimination	
White						
	APHOs	252 (29.5%)	0.28 (0.25-0.34)	0.35 (0.29-0.40)	0.17 (0.06-0.41)	0.12 (0.04-0.30)
	LBW	58 (7.7%)	0.06 (0.04-0.09)	0.11 (0.08-0.15)	0.04 (0.00-0.39)	0.02 (0.00-0.33)
	SGA	105 (14.0%)	0.14 (0.11-0.18)	0.17 (0.13-0.22)	0.01 (0.00-0.97)	0.07 (0.02-0.26)
	Apgar <7	50 (6.1%)	0.06 (0.04-0.08)	0.07 (0.04-0.11)	0.08 (0.02-0.28)	0.02 (0.00-0.25)
	Preeclam- -psia	62 (7.3%)	0.07 (0.05-0.10)	0.08 (0.05-0.11)	0.07 (0.01-0.28)	0.07 (0.02-0.23)
	PPDS	75 (9.3%)	0.09 (0.07-0.14)	0.18 (0.13-0.25)	0.24 (0.09-0.49)	0.13 (0.04-0.34)

Abbreviations: APHOs, adverse perinatal health outcomes; LBW, low birth weight; PTB, preterm birth; SGA, small for gestational age; PPD, postpartum depression

Table 4.5 Difference in log odds estimations of proportions of outcomes by latent class

BCH-estimated difference in log odds

A. Overall		Class 2 vs. Class 1	Class 3 vs. Class 1	Class 4 vs. Class 1	Class 3 vs. Class 2	Class 4 vs. Class 2	Class 4 vs. Class 3
	APHOs	0.04 (0.11)	-0.05 (0.22)	0.98 (0.19)	0.91 (0.25)	0.93 (0.21)	1.02 (0.28)
	PTB	0.29 (0.17)	-0.78 (0.55)	0.96 (0.32)	-0.06 (0.58)	0.68 (0.35)	1.74 (0.65)
	LBW	0.16 (0.19)	0.21 (0.36)	1.29 (0.29)	1.05 (0.41)	1.14 (0.34)	1.09 (0.45)
	SGA	-0.05 (0.15)	0.23 (0.26)	1.07 (0.24)	1.28 (0.31)	1.12 (0.27)	0.84 (0.35)
	NICU	0.00 (0.40)	-0.35 (0.95)	1.07 (0.66)	0.65 (1.05)	1.07 (0.75)	1.42 (1.15)
	Apgar <7	0.09 (0.16)	0.39 (1.18)	1.19 (0.34)	1.31 (0.43)	1.09 (0.06)	0.79 (0.19)
	Preeclampsia	0.08 (0.19)	-0.74 (0.58)	1.27 (0.29)	0.18 (0.62)	1.19 (0.33)	2.01 (0.65)
	PPDS	-1.36 (0.31) **	-0.63 (0.34)	0.18 (0.42)	1.73 (0.22) **	1.54 (0.34)	0.82 (0.36)
B. Black		Class 2 vs. Class 1	Class 3 vs. Class 1	Class 4 vs. Class 1	Class 3 vs. Class 2	Class 4 vs. Class 2	Class 4 vs. Class 3
	APHOs	0.99 (0.16)	0.14 (0.24)	1.24 (0.40)	0.15 (0.26)	0.25 (0.42)	1.11 (0.49)
	PTB	1.09 (0.26)	-0.20 (0.45)	1.59 (0.53)	-0.29 (0.47)	0.51 (0.56)	1.79 (0.74)
	LBW	1.23 (0.25)	0.07 (0.46)	1.83 (0.52)	-0.16 (0.43)	0.59 (0.54)	1.76 (0.70)
	SGA	1.13 (0.19)	0.12 (0.29)	1.53 (0.46)	-0.01 (0.32)	0.39 (0.48)	1.41 (0.58)
	NICU	1.04 (0.67)	0.59 (0.84)	2.37 (0.93)	0.55 (0.92)	1.33 (1.04)	1.77 (1.25)
	Apgar <7	1.19 (0.28)	0.38 (0.39)	0.78 (0.94)	0.18 (0.42)	-0.41 (0.97)	0.41 (1.07)
	Preeclampsia	0.91 (0.28)	0.22 (0.39)	0.55 (0.93)	0.31 (0.42)	-0.36 (0.96)	0.33 (1.06)
	PPDS	1.74 (0.36)*	0.69 (0.53)	1.09 (0.75)	-0.05 (0.53)	0.35 (0.76)	1.39 (0.95)
C. Hispanic		Class 2 vs. Class 1	Class 3 vs. Class 1	Class 4 vs. Class 1	Class 3 vs. Class 2	Class 4 vs. Class 2	Class 4 vs. Class 3
	APHOs	-0.31 (0.27)	-0.23 (0.55)	0.69 (0.75)	0.08 (0.59)	1.00 (0.79)	0.92 (0.94)
	PTB	-0.04 (0.45)	0.81 (0.69)	1.00 (1.25)	0.85 (0.79)	1.03 (1.31)	0.19 (1.43)
	Apgar <7	-1.21 (1.05)	1.11 (0.71)	2.25 (0.86)	2.32 (1.29)	3.47 (1.37)	1.15 (1.08)
D. White		Class 2 vs. Class 1	Class 3 vs. Class 1	Class 4 vs. Class 1	Class 3 vs. Class 2	Class 4 vs. Class 2	Class 4 vs. Class 3
	APHOs	0.27 (0.17)	-0.65 (0.61)	-1.05 (0.58)	0.08 (0.65)	-0.31 (0.59)*	0.61 (0.83)
	LBW	0.62 (0.30)*	-0.59 (1.48)	-1.24 (1.68)	-0.22 (1.54)	-0.86 (1.70)	0.36 (2.24)
	SGA	0.25 (0.23)	-2.50 (3.92)	-0.70 (0.77)	-1.75 (3.97)	0.05 (0.79)	2.79 (4.02)
	Apgar <7	0.22 (0.34)	0.34 (0.82)	-1.00 (1.41)	1.13 (0.91)	-0.22 (1.44)	-0.34 (1.61)
	Preeclampsia	0.09 (0.31)	-0.04 (0.87)	0.04 (0.70)	0.88 (0.95)	0.95 (0.74)	1.08 (1.10)
	PPDS	0.72 (0.29)*	1.10 (0.61)	0.35 (0.66)	1.38 (0.67)	0.63 (0.67)	0.25 (0.86)

*p<0.05, **p<0.01; Significant p-values bolded; P-value determined by test Wald test

Abbreviations: APHOs, adverse perinatal health outcomes; LBW, low birth weight; PTB, preterm birth; SGA, small for gestational age; PPD, postpartum depression

CHAPTER FIVE
MANUSCRIPT TWO

Title: For which patients is group prenatal care a good fit? A mixed methods study of group prenatal care attendance

Abstract

Introduction: Maternal and neonatal health in the US lags far behind peer nations. Enhancing the quality of prenatal and postpartum care reflects one strategy to improve perinatal health. Group prenatal care (GPNC) models represent one promising alternative to the standard individual prenatal care (IPNC) model. Despite some promising findings, evidence of GPNCs superiority has been inconsistent. The present study explores for what patient GPNC is a good fit through an examination of patient characteristics associated with session attendance and an exploration of the patient experience in GPNC compared to IPNC.

Methods: A concurrent mixed methods approach was applied in the analysis of secondary data collected in a randomized control trial and associated program evaluation interviews. The primary outcome of quantitative analysis was session attendance among patients assigned to GPNC (n=1068). Primary predictors of interest were sociodemographic, psychosocial, health and health behavior characteristics. The association of patient characteristics with session attendance was assessed using Zero-Inflated Poisson (ZIP) regression. Serial interviews with patients attending GPNC and IPNC (n=31) were analyzed using thematic analysis.

Results: Varied sociodemographic (age, nativity, relationship status, education) psychosocial (prenatal distress, stress, housing instability, life stressors), health (gestational diabetes) and health behavior (smoking) characteristics were significantly associated with rate of attendance

($p < 0.05$). GPNC offered patients alternative opportunities for socialization, learning and engagement, as well as posing unique threats to satisfaction.

Discussion: Patient groups differ in their rate of session attendance. These differences may be due to the differential experience offered in GPNC or to unique barriers faced by these patients to attend GPNC. Findings offer insight to enhance targeted recruitment, as well as for model modification. Future studies are needed exploring the relationship between patient characteristics, GPNC experience and barriers encountered in attending GPNC.

Keywords: prenatal care, group prenatal care, centeringpregnancy, perinatal health

Introduction

The United States (US) ranks far behind peer nations in perinatal health, despite substantially greater per capita health care spending.^{1,2} Perinatal health in the US is characterized by large racial disparities that that have persisted and even widened over time.^{3,4} Quality prenatal and postnatal care is one important determinant of perinatal health.⁵

Despite rapid advances in technology, guidelines for prenatal care in the US have remained relatively unchanged over the past century.⁶ Standard prenatal care involves a one-on-one encounter between the provider and patient with increasing frequency over the course of pregnancy.⁷ The dominant individual prenatal care (IPNC) model can result in brief visits with long wait times, leaving care feeling rushed, impersonal and fragmented.⁸ One promising alternative to standard IPNC is the Group prenatal care (GPNC) model. Group care models have been implemented for a variety of health conditions and are theorized to provide benefit to patients through increased contact time with providers, reduced hierarchy between patient and provider, enhanced education, social support from fellow participants, and the formation of healthy social norms in the group.⁹

CenteringPregnancy is a popular model of GPNC, developed and trademarked by the Centering Healthcare Institute (CHI)¹⁰. GPNC is an innovative model of prenatal care that integrates physical assessment with extensive education and social support.¹¹ Groups of 8 to 12 pregnant patients with similar delivery dates receive prenatal care together over a series of ten 2-hour sessions, following the same visit schedule as IPNC. GPNC is designed such that all prenatal care occurs in the group following the initial assessment, with the exception of health concern requiring privacy and cervical examinations in late pregnancy. Groups are facilitated by a consistent pairing of a certified health provider (obstetrician, nurse practitioner or midwife) and co-facilitator (registered nurse or social worker). CenteringPregnancy was founded upon a set of 13 essential elements for effective GPNC (Figure 1).¹²

At the start of each group session, patients participate in self-assessment, measuring and recording their own weight and blood pressure. Patients then receive an individual physical assessment from the provider in the group space (e.g., measurement of fundal height and fetal heartbeat). During this time, time is provided for socialization among group members. The remaining 60-90 minutes are spent in a provider facilitated group discussion on the topics of pregnancy, childbirth, and parenting aligned with group gestational age (Figure 1).¹³ Discussions follow a curriculum developed by the CHI that is adapted by providers to address concerns and priorities of the group.

While showing promise, evidence of GPNC's enhanced effect are inconsistent.¹⁴ Early randomized control trials (RCTs) and observational studies including large, matched cohort studies have found GPNC results in more favorable perinatal outcomes than IPNC.^{15, 16,17,18,19,20} Yet, recent metaanalyses of RCTs suggest the effect of GPNC is equivocal to IPNC.^{21,22} The discrepancy between RCT and observational studies may in part be attributed to the effects of

selection bias.²² In observational studies patients typically choose their preferred model of care and even with modern matching approaches unmeasured factors may influence participant choice of perinatal health. Characteristics of patients that select GPNC may contribute to the models enhanced effect. These patients may be healthier, more engaged in their care or may have received stronger encouragement from their provider to attend GPNC. Participant adherence to the intervention must also be considered when examining the effects of GPNC.¹⁷ Previous studies document consistent poor session attendance, even in the highly controlled trial environment where additional supports are offered substantial adherence challenges are encountered. Approximately 20% of patients assigned to GPNC do not attend a single GPNC session.^{23,24}

While offering potential benefits, GPNC may not be a one size fits all strategy. Few studies have investigated the characteristics of pregnant persons who attend GPNC. These existing studies present inconsistent findings. Younger, nulliparous patients, with post-secondary education, who did not stop smoking prior to intake, with average pregnancy knowledge and higher levels of stress have been found to be more interested in attending GPNC.^{25,26,27} Adolescents born outside the US, those in groups comprised of pregnant persons of more diverse ages and with higher perceived family support are more likely to attend GPNC.^{28,29,30} Other studies have found no difference in GPNC interest or attendance by patient characteristics.^{26,31}

Since GPNC may improve perinatal health outcomes compared to standard IPNC, it is important to understand GPNC attendance patterns and associated factors. The present study sought to better understand for what patients GPNC is a good fit. Using a concurrent mixed methods approach, this study draws from quantitative data collected in a RCT comparing GPNC

to standard IPNC in combination with qualitative interviews collected through associated program evaluation. This study aims to 1) determine whether pregnant persons' sociodemographic, psychosocial and health characteristics predict differential rates of GPNC session attendance among patients randomly assigned to GPNC through quantitative analysis and 2) to compare the perceptions of pregnant persons receiving GPNC to peers receiving IPNC through qualitative analysis, providing context for observed attendance patterns. By examining data collected in a RCT, the present study benefits from random assignment, reducing the effect on selection bias on sample selection.

Methods

Design

A concurrent mixed methods design comprised of independent data collection and analysis, followed by integration of quantitative and qualitative results was utilized.³² This approach was taken to complement each method and provide a more complete picture of how and why patients attend GPNC. In the interpretation phase qualitative and quantitative findings were synthesized, resulting in a more comprehensive understanding of GPNC attendance than quantitative or qualitative findings alone.

Setting and Participants

This project was conducted as a secondary data analysis of data from a larger randomized controlled trial, the Centering and Racial Disparities (CRADLE) trial and coordinated evaluation efforts, CRADLE Study Process Evaluation (CSPE). The primary objective of the CRADLE trial was to assess whether participation in GPNC reduced rates of preterm birth and low birth weight when compared to IPNC and to investigate whether GPNC reduced racial disparities in these

rates between black and white patients. Findings from the primary analysis have been published previously.³³

Methods of the CRADLE study have been described in detail previously.³⁴ CRADLE study participants were recruited at a single hospital affiliated obstetrics practice in South Carolina serving a large medically underserved population. The trial took place between April 2016 and January 2021. Patients were eligible for inclusion if they were between the ages of 14 and 45, entered care prior to 21 weeks gestational age and were able to be enrolled by 24 weeks gestational age. Exclusion criteria included medical (e.g. pre-gestational diabetes, severe chronic hypertension, any disease requiring chronic immunosuppression and severe obesity with a body mass index greater than 50 kg/m) pregnancy (e.g. multiple gestation or planned cervical cerclage), social or behavioral (e.g. severe psychiatric disorder, active substance use or incarceration) complications that would preclude prenatal care or delivery by a nurse practitioner or indication of for planned preterm birth. A racially diverse sample of 2,348 medically low risk patients consented and were enrolled. Participants were stratified by race and randomly assigned (1:1) to attend GPNC (n=1175) or IPNC (n=1173).

Patients were recruited upon entry to prenatal care and followed through 12-weeks postpartum. Data was collected at three time points: baseline, in the third trimester and 12-weeks postpartum. Upon enrollment and again in the third trimester, participants completed surveys composed of validated sociodemographic, psychosocial, and behavioral measures. Following 12-weeks postpartum, maternal health history, service use, delivery, and birth outcomes were abstracted from maternal and infant electronic medical records. Participants were compensated \$25 for their participation at the time of survey 1 and survey 2 if they completed at least five

visits in their assigned model of prenatal care. For the current study quantitative analysis will be limited to participants who were assigned to GPNC arm.

In coordination with the CRADLE trial, a program evaluation was conducted with the objective of assessing fidelity to the CenteringPregnancy model. Several methods of data collection were utilized in this aim. The present study will focus on data collected through serial semi-structured interviews of patients in GPNC and IPNC. Interview patients were recruited using purposeful sampling and GPNC patients attending groups lead by a variety of providers targeted. GPNC patients were eligible to participate if they had attended two GPNC sessions. Patients who attended GPNC for a previous pregnancy and who were enrolled in the CRADLE study were prioritized. IPNC patients were eligible to participate if they attended one routine prenatal care visit prior to 16-weeks gestational age, with CRADLE participants again prioritized. Additional sample inclusion criteria included access to a cellphone and no intention to move prior to delivery.

The CRADLE trial (Pro00043994) and CSPE received institutional review board approval from the Prisma Health Office of Human Research Protection.

Measures

Patient Characteristics

A variety of patient characteristics were collected through survey and medical record abstraction. Selection of patient characteristics of interest was informed by previous studies of group prenatal care attendance. If measures were conducted at both time points for example depression symptoms, only survey one reports were assessed to avoid capturing potential intervention effects.

Sociodemographic characteristic variables were collected at the baseline survey or through medical chart abstraction. Maternal age (calculated based on date of birth) and parity (dichotomized as nulliparous and primiparous/multiparous) were assessed in the medical chart. Participants reported their race and ethnicity, nativity, language, relationship status, educational attainment, school enrollment, employment status and health insurance status in the previous year. Participant race and ethnicity was classified as non-Hispanic Black, Hispanic, non-Hispanic White and “other race and ethnicity”. Participants pregnancy intention and feeling about pregnancy were measured using items adapted from the Pregnancy Risk Assessment Monitory System questionnaire and classified respectively as intended and unintended and happy, unhappy, or not sure of feelings.³⁵

Several items assessed participant mental health, general and pregnancy specific stressors. Symptoms of depression were measured using the Center for Epidemiological Studies Depression Scale (CES-D) adapted for use in pregnant populations and classified as of clinical concern (<12) or not reaching clinical concern (≥ 12).³⁶ To assess anxiety arising from pregnancy concerns participants completed the Pregnancy-Specific Anxiety Scale (PSAS).³⁷ How worried or bothered participants were concerning 17 common stressors in pregnancy was assessed using the Prenatal Distress Questionnaire (NUPDQ).³⁸ Participants provided self-report of their neighborhood safety.³⁹ For measures of pregnancy related anxiety, prenatal distress perceived stress and perceived neighborhood safety an average score was calculated, and participants classified as below average (a score of -1SD below the mean), average (a score within 1SD above and below the mean) and above average (a score of +1SD above the mean). Housing instability was measured as 2 or more moves in the last year based on previous research.⁴⁰ Participants also reported other housing issues that occurred in the previous year such as having

received an eviction or foreclosure notice as well as food insecurity in the previous month.⁴¹ Participants indicated whether they experienced seven life stressors such as job loss or the death of a loved one during pregnancy using items adapted from the PRAMS questionnaire.⁴² Participants perceived experience of discrimination was measured using the Everyday Discrimination Scale (EDS) and items assessing discrimination in prenatal care.⁴³ Participants indicated the level of support they received from family as well as the father of their baby during pregnancy.

Health and health behavior characteristic were determined via the medical chart and included body mass index (BMI), medical conditions, substance use during pregnancy and service use. Body mass index (BMI) at initial prenatal care visit was determined from height and weight and ranges formed (underweight, <18.5; healthy, 18.5 to <25; overweight, 25 to <30; and obese, ≥ 30). Presence of maternal health conditions of gestational diabetes (GDM), chronic hypertension (CHTN) and gestational hypertension (GHTN) were determined via medical chart review. Self-reported substance use at survey 1 included cigarette smoking, alcohol use and marijuana use during pregnancy. Cigarette smoking was classified as none, smoked in 3 months prior but quit and any smoking during pregnancy. The number of ultrasounds received was collected from medical chart review. This variable was intended as another potential indicator of medical complications, as suspected or confirmed conditions are typically associated with enhanced monitoring. Participants self-reported auxiliary service use at survey two, including use of food assistance programs, home visits with a nurse, mental health counseling or other public assistance programs.

Attendance Variables

The primary outcome of quantitative analysis was GPNC session attendance. Total GPNC session attendance was deemed to be more representative of the “dose” of intervention received and the patient’s pattern of attendance than alternatives such as the proportion of eligible sessions attended. Participant prenatal care attendance was abstracted from the electronic medical record and a count variable of session attendance calculated. A measure of IPNC visit attendance and total number of prenatal care visits/session attendance following enrollment were also calculated. Participant eligibility to attend GPNC sessions was derived from the month of study enrollment and delivery date, similar to the calculation of the Kotelchuck adequacy of prenatal care index but with a maximum of 10 sessions.⁴⁴

Participant Interviews

Following informed consent and enrollment, CSPE participants participated in interviews guided by a semi-structured interview guide. Interview guide questions were structured around the session/visit process and differed by prenatal care model (Figure 2). Participants were asked to describe their most recent prenatal care visit, the most meaningful aspect of the visit and trust with their provider or provider and group. Participants received a \$5 incentive for each interview. Interviews were intended to last between 10 and 15 minutes and the interviewer to remain consistent over subsequent interviews, as to encourage the development of trust. Interviews were audio recorded and took place in person as well as via telephone in rare cases.

Quantitative Data Analysis

Participants with pregnancies resulting in spontaneous abortion (n=47) and missing attendance information (n=60) were excluded from analysis due to ineligibility to attend sessions after 21 weeks or missingness on the outcome variable of interest. In total 1,068 pregnant persons allocated to attend GPNC were included in the analytic sample. Descriptive statistics including

mean (standard deviation, SD) for continuous variables and counts with percentages for categorical variables were calculated to describe sample characteristics and prenatal care attendance. As session attendance was a count variable with a high prevalence of zero values, a Zero-inflated Poisson (ZIP) regression was used to assess the association between patient characteristics and session attendance. The ZIP model assumes that excess zeros occur due to a separate process than count values and should therefore be modeled independently. The ZIP model therefore consists of two parts a Poisson count model and a logit model that predicts the log odds of excess zeros. The count regression identified factors associated with the increase in the total number of sessions attended. While the zero-inflated regression identified factors specifically contributing to participants attending zero sessions. Adjusted models controlled for the number of sessions participants were eligible to attend. Significance was determined at a $p < 0.05$. Missing data from the questionnaires or medical chart review were coded as “missing” for data analysis. Data were analyzed using SAS 9.4 (SAS Institute INC, Cary NC).

Quantitative Results

Participant sociodemographic, psychosocial and health characteristics are presented in Table 1. Participants mean age was 25.3 years (SD=5.42). Participants identified as 40.7% non-Hispanic Black, 22.1% Hispanic, 35.8% non-Hispanic White and 1.4% as “other” race or ethnicity. Forty percent of participants were married to the father of their baby. The majority of patients were born in the US (82.3%) and preferred to speak English (83.1%). Around half of participants had an annual household income of below \$20,000 (49.8%), had a high school education (53%) and were multiparous (55.5%).

Attendance

Participants attended an average of 4.8 sessions (SD=3.54). Based on when participants enrolled in the study and date of delivery, participants were eligible to attend an average of 9.52 sessions (SD=1.17). Figure 3 displays participants rate of session attendance alongside the proportion of sessions participants were eligible to attend. In addition to GPNC sessions, participants attended an average of 5.69 IPNC visits (SD=3.83). On average participants attended 10.50 prenatal care visits overall (SD=3.45).

Count Model

Table 2 summarizes the results of the Poisson model. Following adjustment for session eligibility, the sociodemographic characteristics of older age (B[SE]: 0.01[0.00], $p<0.05$) and foreign nationality (B[SE]: 0.11[0.04], $p<0.01$) were associated with attending more GPNC sessions. By contrast, being in a committed dating relationship or engaged rather than married (B[SE]: -0.09[0.04], $p<0.01$), less than a high school education (B[SE]: -0.13[0.04], $p<0.01$) and household income of less than \$10,000 (B[SE]: -0.09[0.05], $p<0.05$) were associated with less session attendance. Among psychosocial characteristics, having average prenatal distress compared to below average prenatal distress was associated with more session attendance (B[SE]: 0.09[0.04], $p<0.05$). Housing instability (B[SE]: -0.09[0.05], $p<0.05$), housing issues (B[SE]: -0.13[0.05], $p<0.01$) and life stressors in pregnancy (B[SE]: -0.08[0.04], $p<0.05$) were associated with less session attendance. Two health characteristics were found to be associated with less session attendance: GDM (B[SE]: -0.24[0.06], $p<0.001$) and any cigarette smoking during pregnancy (B[SE]: -0.09[0.04], $p<0.05$). The remaining participant characteristics were not significantly associated with session attendance in the count model.

Zero-Inflated Model

Table 3 summarizes the results of the logit model. In the adjusted model, older age was associated with reduced odds of non-attendance (B[SE]: -0.03[0.01], $p < 0.05$). The psychosocial characteristic of average or above average perceived stress were associated with increased odds of non-attendance (B[SE]: 0.53[0.23], $p < 0.05$; B[SE] 0.69[0.29], $p < 0.05$). The remaining participant characteristics were not significantly associated with attending no sessions.

Qualitative Data Analysis

In qualitative analysis of participant interviews, audio recordings were transcribed verbatim and Spanish language interviews were translated into English. A reflexive thematic analysis of interviews was conducted following Braun and Clarke's six phase process of: data familiarization, systematic coding, collation of codes and generation of initial themes, review and refinement of themes, and production of report.⁴⁵ This framework was selected as it provides a flexible method to identify patterns of meaning across data. An inductive data driven approach to analysis was taken. Initially, the first author read transcripts in their entirety, making note of initial coding ideas. The first and third author then each independently coded a portion of interviews from participants of both prenatal care models (18 interviews: 9 GPNC and 9 IPNC), discussing and ensuring consistency of understanding. Following these discussions, the first author coded all interviews, collated codes and compared between models of prenatal care. Codes were grouped into candidate themes representing patterns of meaning within the data. Themes were further refined, and names and definitions generated. Memos documenting decision rationale were kept throughout the study creating an audit trail which was reviewed by the third author. Transcripts were managed and analyzed using NVivo March 2020 release (QSR International Pty Ltd).

Qualitative Results

Thirty-one participants were interviewed, 10 attending GPNC and 21 IPNC (Table 4).

Participants were interviewed between 1 and 6 times, resulting in 79 interviews overall: 30 GPNC and 49 IPNC. On average, interviews with IPNC participants were shorter than those with patients attending GPNC, average durations of 5 and 13 minutes respectively. Interviews took place primarily in the second and third trimester. The interviews of two participants were conducted in Spanish and all others were conducted in English. Support persons were present at 20 interviews, 6 GPNC and 14 IPNC.

The mean age of participants was 26.5 years (Table 5). Ten participants identified as non-Hispanic Black, 9 Hispanic and 12 non-Hispanic white. Most participants had a high school education, an annual income of less than \$20,000 and were multiparous/primiparous. Nine participants were married, 7 in a committed dating relationship or engaged and 13 were single or not in a committed relationship. Within their assigned model of care, GPNC participants on average attended 6.0 sessions and IPNC participants attended 10.7 visits (Table 6). GPNC participants attended an average of 4.5 individual care visits for a total of 11.0 visits/sessions. On average GPNC participants received more than half of their prenatal care in GPNC. IPNC participants did not attend any GPNC sessions, therefore average total PNC visits/sessions was equal to mean individual care visits. The majority of participants in both care models received adequate or greater than adequate care.

Themes

Five themes related to pregnant persons' experience in prenatal care were identified when comparing the interviews of patients receiving IPNC to those receiving GPNC. These themes included 1) monitoring of fetal wellbeing, 2) the patient-provider relationship, 3) engagement

and education, 4) trust in and support from peers and 5) involvement of support persons (Figure 3). The contents of themes varied between prenatal care models, converging, and diverging. Four of the five themes were present among both models of prenatal care, whereas “trust in and support of peers” was present only among patients receiving GPNC.

Monitoring of fetal wellbeing

Patients in both care models were unified in their prioritization of fetal monitoring as the most important aspect of the prenatal care visit. Pregnant patients looked forward to hearing the fetus’s heartbeat at each visit, as it reassured them of the fetus’s wellbeing and offered tangible evidence of the pregnancy in early pregnancy. One woman summarized this sentiment stating, “It is the only thing we want to know that the baby is well.” (GPNC, second trimester) Another patient stated “She [the provider] comes in and examines everything...it just makes me feel like the baby is okay and I am okay.” (IPNC, second trimester) When providers were unable to locate the fetus’s heart tones quickly, it caused some pregnant persons to worry. Pregnant persons were excited to share the experience of listening to the fetus’s heart tones with partners and older children.

Patient-provider relationship

The majority of pregnant persons in both care models expressed trust in their provider, in the information shared, as well as that disclosures would be accepted and confidential. Pregnant patients attributed the trust they felt in their provider to positive patient-provider interactions, stressing the significance of their providers demeanor. Pregnant patients valued displays of warmth, friendliness, humor and caring from their provider. Caring was demonstrated through invitations for pregnant patients to share their concerns, addressing patient concerns thoroughly and simple acts such as offering the patient a snack. Many pregnant patients voiced a preference

to receive care from familiar providers, whom they had history either build over previous visits or in a previous pregnancy. Pregnant patients voiced feeling as if familiar providers knew them and had a better understanding of their pregnancy. Pregnant patients valued when their provider followed up on discussions from a previous visit or referred to personal details. One woman stated, “It is not like you are just another patient it is like she remembers you.” (IPNC, third trimester) Among the interview sample, pregnant patients receiving IPNC were more likely to be exposed to multiple providers over the course of care. Pregnant patients seeing unfamiliar providers described needing to relay their history and re-explain any issue they were experiencing at each visit. One woman voiced her dissatisfaction stating, “With my other kids, I only had one doctor and I did not have to tell my whole history over and over and over. They knew exactly what to do and what to look for. It is more comfortable than having a stranger just come in and ask you the same questions and touch you and probe.” (IPNC, third trimester) While some pregnant patients were displeased to receive care from multiple providers, others saw it as an opportunity to increase the likelihood they would know their delivering provider.

While a majority of pregnant persons spoke highly of their providers, a minority of pregnant persons in both care models described situations where their provider was rude or dismissive of their concerns. These situations damaged the patient’s trust in their provider as well as their satisfaction with care. In GPNC, pregnant patients were able to observe the providers navigation of confidentiality between one-on-one and group discussion. Pregnant patients described instances where respect for this boundary increased or decreased trust in their provider. One woman remarked, “If you have your one-on-one time with her and you share something with her, she will not just bring it up in group. If it is something that she feels should be shared with the group, she would definitely ask if you are okay with sharing it.” (GPNC,

second trimester) Whereas a support person recalled how the manner in which the provider spoke about a patient's weight in the group resembled gossiping stating, "That is how rumor and gossip spreads!" (Support Person, GPNC, second trimester)

Engagement and education

Pregnant persons' descriptions of IPNC centered around question and response interactions with providers. A majority of IPNC patients reported satisfaction with the informational support offered, feeling that their concerns were adequately addressed through the providers response to their questions. Many pregnant patients described their provider as inviting questions at the start of each visit. One woman in IPNC reported, "I pretty much asked her what I needed to find out from her." (IPNC, third trimester) The amount of informational support supplied appeared to vary with the quantity questions or concerns raised by the patient, as well as pregnancy complications experienced. Several patients in IPNC reported they did not have any questions for their provider. While some patients in IPNC reported their provider covered "everything", a few reported receiving little information during their visit. One woman stated, "We really don't talk about anything. They just check me and then say okay". (IPNC, third trimester) Pregnant persons in GPNC reported a similar question and response exchange with providers during one-on-one time. While not reported by GPNC patients, a woman receiving IPNC who attended GPNC for a previous pregnancy, recalled feeling like she did not have enough time to ask her questions during her one-on-one time with the provider.

In addition to one-on-one question and response, several pregnant persons in GPNC remarked upon the benefits of hearing provider responses to the questions asked by peers, as well as the stories and advice shared by group members, particularly those who gave birth previously. Information shared by peers included symptom remedies, contraception side effects, product

recommendations and advice on caring for the infant following birth. One patient described the advice offered by peers stating, “They have experiences of how to care for a baby, what to take to the hospital on the day of labor and all those things.” (GPNC, third trimester) The activities and videos utilized by providers to introduce prenatal education topics were described by most patients in GPNC to be fun and interesting. Additionally, the majority of pregnant patients found self-assessment to be easy and automatic following the initial session. A few patients in GPNC noted the skills they learned by participating in self-assessment activities. One woman remarked, “If you know how to do it here, you know how to do it at home. If you have the device, you can do it at home too.” (GPNC, second trimester)

Parity was embedded within pregnant patients’ discussion of satisfaction with informational support provided. Nulliparous patients commonly reported a higher need for informational support. While some multiparous patients viewed their informational needs to have lessened over subsequent pregnancies, others reported a sustained need for prenatal education, particularly in cases where significant time had lapsed. One woman in IPNC who attended GPNC for her first pregnancy noted, that while she valued the education GPNC provided, she no longer required that level of informational support. Though the information delivered in GPNC was described by a number of patients to be most helpful for first-time moms, multiparous patients also reported gaining novel information. One multiparous woman stated, “The topics are the same as the last time we did centering. It is the same, except the questions from the others in the group make it different from the last time.” (GPNC, second trimester)

Trust in and support from peers

Nearly all GPNC patients reported trusting group members, feeling they could share openly, without embarrassment or judgement. Pregnant persons described being able to “throw it all out

there” confident that they would receive a positive response from peers. One woman stated, “When someone tells a story everyone is interested in giving feedback and nothing was negative... even if they did think something else, they only said the positive stuff.” (GPNC, second trimester) Pregnant patients described trust in group members as more challenging in the beginning and developing over the time spent together. Several pregnant patients identified the active participation of group members as essential for trust to build. One woman stated, “I think once someone tells their personal story it kind of makes it easier for someone else to do that too.” (GPNC, third trimester) A few patients identified providers discussions of confidentiality at the initial session, as well as continued reminders to support the development of group trust. The majority of pregnant patients believed group members would maintain their privacy, or that if details were shared, they would not connect back to the patient. While many GPNC patients reported high trust, one woman reported she would not confide in all group members and a woman receiving IPNC who attended GPNC for a past pregnancy recalled reserving personal questions such as those about intercourse for one-on-one time with the provider.

Many pregnant patients in GPNC reported bonding with their group. Groups were described to show interest in each other’s lives, catching up at each session. One woman commented, “It is nice to have some time to talk with other women. We are going through pregnancy together and everyone seems to be genuinely interested in how our weeks are going outside of pregnancy. It is a nice support system.” (GPNC, third trimester) Many pregnant patients expressed that hearing the experiences and emotions of peers that were similar to their own let them know they were not alone, a sentiment which was particularly meaningful for participants who previously underwent a traumatic pregnancy experience. A patient whose previous pregnancy ended in a miscarriage noted, “When it happens you think it only happens to

you but there are lots of people that it has happened to.” (GPNC, second trimester) Several pregnant persons noted that similarities with peers enhanced the formation of connections. One patient stated, “Seeing that we are all going to be going through the same thing it has caused more of us to be more trustworthy of each other.” (GPNC, second trimester)

Involvement of support persons

Pregnant patients in both care models described varying levels of participation from their partner, ranging from sitting quietly to asking many questions. Several patients reported having their partner in attendance was beneficial, as they asked additional questions, assisted them in remembering recommendations and it improved their partners understanding of what was going on in pregnancy. Describing his involvement, one support person commented, “We talk back and forth. We get information on the best way to help her and in previous visits she [the provider] informed me what was going on with her and that helped me a lot.” (Support person, IPNC, third trimester) Some patients in IPNC reported their provider included their partner in the visit by directing questions to their partner, inviting questions from their partner and by laughing and joking with their partner. Pregnant patients in GPNC noted benefits and challenges to support person involvement in a group setting. One woman described her partner as initially hesitant to attend sessions for fear that he would be the only male. A few partners commented on the benefits of hearing other fathers share questions and concerns. One woman’s partner stated, “I mean people saying they are nervous... that helps other people open up more.” (Support person, GPNC, second trimester)

Integration

Combining quantitative and qualitative results provides an enhanced understanding of which patients attend GPNC and why (Figure 4). Patient characteristics associated with patterns of

attendance (eg. age, relationship status, education, income, prenatal distress, perceived stress, housing instability, housing issues, life stressors, GDM and smoking) may represent a match between the care experience offered in GPNC and care needs. Interviews illustrate alternative opportunities for learning, engagement and peer connection offered in GPNC. Though GPNC patients generally presented as satisfied, potential threats to care satisfaction arose including how the provider navigated patient confidentiality between one-on-one and group discussion and in the need to make partners feel comfortable joining the group. The observed relationships between patient characteristics and session attendance could also illustrate characteristics association with barriers to session attendance. These barriers may relate to the real or perceived structural and process elements of GPNC or could represent overarching access barriers.

Discussion

The present study applied a concurrent mixed methods approach in the investigation of for what patients GPNC is a good fit. We addressed this question by examining patient characteristics associated with GPNC session attendance, as well as exploring how patient experiences in GPNC differed from those in GPNC. Our findings suggest session attendance is associated with a diverse array of sociodemographic, psychosocial, health and health behavior characteristics. The observed associations are largely consistent with a hypothesis that pregnant persons of greater disadvantage attend fewer GPNC sessions, though some associations contradict what might be expected.

Our finding that greater education, foreign nativity is associated with increased GPNC participation is consistent with previous research.^{27,28} While foreign born pregnant persons are typically more disadvantaged, it is theorized that the social support offered in GPNC may be particularly attractive to these pregnant persons or that GPNC may be consistent with the more

collectivist cultures in which they were born. Pregnant persons in committed relationship vs. married, with an annual income of \$10, 000 or less, with unstable housing and housing issues and those experiencing more life stressors (ex. job loss, recent death of loved one) attended fewer GPNC sessions. Hardship in pregnant persons' lives might prevent them from attending GPNC sessions. Barriers associated with these characteristics may not be unique to GPNC. Financial and material constraints such as unemployment, poor or insecure housing and having multiple moves during pregnancy have also been linked to poor utilization of standard IPNC as well.⁴⁶ By contrast, our finding that being diagnosed with GDM is associated with decreased attendance is not consistent with the IPNC literature in which high medical risk is often associated with greater than adequate IPNC.⁴⁴ Patients with GDM may experience unique barriers to attending GPNC, such as interference with additional testing or GDM education, a lack of GDM specific content or could reflect provider perceptions that GDM can be better monitored in IPNC.

In some cases, our findings contradicted those of previous studies. For instance, while we found older age to be associated with elevated session attendance, a previous study found younger adolescents (16 or younger) were more likely to be interested in GPNC participation.²⁵ This discrepancy might be explained by our measurement of actual attendance vs. interest or to the wider age range included in our study. In a previous study, pregnant patients with higher stress showed greater interest in GPNC.²⁶ Our findings related to stress, are somewhat conflicting. While average vs. below average prenatal distress was associated with greater attendance, pregnant persons with average and above average perceived stress were more likely not to attend a single session. This suggests pregnant persons may be more likely to attend GPNC if they feel some worry about common pregnancy concerns yet be less likely to try GPNC

when experiencing stress in several life situations. Lastly, while one study found pregnant persons who stopped smoking at intake were less likely to be interested in GPNC, we find smoking during pregnancy is associated with reduced session attendance.²⁶ This finding is consistent with a hypothesis that pregnant persons who smoke during pregnancy may experience stigma in the group environment. Additionally, this characteristic might represent wider engagement in poor health behavior and reduced motivation for change.

Only two studies of GPNC are known to have included a qualitative comparison group in the examination of pregnant patients' experience in GPNC.^{47,48} Consistent with our findings related to enhanced opportunities for education and engagement, GPNC was found to function similarly to IPNC on several domains yet offered more and different benefits for education and preparation, through guided discussion of curriculum, open question and answer time with the group and the opportunity to hear from peers.⁴⁷ In keeping with our theme of "trust in and support from the group", a comparison of GPNC to IPNC in a military setting found GPNC care offered patients a sense of community and that hearing the stories of other patients that were similar to their own helped pregnant persons feel that they were not alone in the pregnancy experience.⁴⁸ Privacy and confidentiality concerns in the group setting have also been identified previously.⁴⁷

Strengths

The present study has several strengths. First, is the utilization of a mixed methods design that combines the strengths of quantitative and qualitative data collection.³² Second, the study sample was relatively large and racially diverse subset of RCT participants from a practice with an established GPNC program. Third, a broad range of sociodemographic, psychosocial and health factors were measured using validated instruments, and patients' attendance was abstracted via

medical chart review. Finally, qualitative analysis utilized a qualitative comparison group, which is rare in health research. Inclusion of a comparison group allowed for informed conclusions to be made about the similarities and differences between care models, enhancing study rigor.⁴⁹

Limitations

However, the study also had limitations. First, the quantitative analysis is descriptive in nature and findings may not represent a causal relationship. Second, the RCT sample was largely low-income pregnant persons from a single practice, findings may not be generalizable to other populations. Third, there is missing data on several survey measures, particularly those measured in the third trimester. Non-completion of the second survey is likely associated with poor clinic attendance. Missing data was coded as “missing”, and analysis restricted to individuals with complete data (complete case). Lastly, qualitative interviews were conducted as part of a feasibility assessment and likely oversample pregnant persons adhering to assigned care at the time of interview. This may have resulted in more favorable impression of the prenatal care model presented. Pregnant persons may also not have felt comfortable presenting critiques of their care, despite relationships formed over serial interview.

Implications

Despite these limitations, the current study offers insight for patient recruitment and retention in GPNC, as well as possible modifications to the model. GPNC can only achieve an effect to the extent it is attended. Our findings suggest some pregnant persons may be less likely to receive the necessary treatment “dose”. The Michigan Plan for Appropriate Tailored Healthcare in pregnancy an expert review of prenatal care delivery, recommends that services should be tailored to the medical and social determinants of health needs of the patient, directed by risk assessment occurring upon entry to care.⁵⁰ Such as risk assessment could identify patients at

elevated risk of poor GPNC attendance and targeted supports provided. Modifications to the GPNC model that could further facilitate session attendance should be considered, such as coordination of additional medical monitoring with group for patients diagnosed with GDM.

This study adds to literature that can inform shared decision-making between providers and patients, wherein benefits, barriers and value match of prenatal care selection is discussed.⁵¹ Further research examining why identified groups attend fewer sessions and what supports, or model alterations patients desire. Research should also investigate if and how these barriers differ from those of attending standard individual care. It may be the case that different care models are already better tailored to the needs of certain pregnant persons.

Our study measured session attendance. In many cases, this measure does not equate to overall prenatal care attendance. Patients assigned to GPNC were able to switch to IPNC at any time, as well as to seek additional IPNC visits as needed or desired while attending GPNC, such as for a make-up visit if they missed their GPNC session. This is reflected by the average attendance at 5.7 IPNC visits among patients assigned to GPNC, resulting in a majority of GPNC patients receiving mixed care. Results presented therefore do not necessarily reflect predictors of adequacy of prenatal care. However as noted some results do align with general adequacy of prenatal care literature. Future research is needed to clarify this relationship.

Conclusion

Access to quality prenatal care is one avenue through which perinatal health is promoted. GPNC may represent a good fit for some but not all patients. Our study suggests patient sociodemographic, psychosocial, and health characteristics are associated with differential rates of GPNC attendance. Differential attendance may result from the match between patient needs and the elements of GPNC including additional opportunities to learn, engage and receive social

support, as well as from barriers these patients encounter in attending GPNC. Enhanced knowledge of characteristics associated with attendance alongside the patient experience in GPNC, can inform model adaptation as well as recruitment and facilitate joint decision making in the selection of prenatal care

References

1. Tikkanen, R., Gunja, M. Z., FitzGerald, M. & Zephyrin, L. Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries. (2020)
doi:10.26099/411V-9255.
2. Organization for Economic Cooperation and Development. CO1.1. Infant mortality.
www.oecd.org https://www.oecd.org/els/family/CO_1_1_Infant_mortality.pdf.
3. Singh, G. K. & Yu, S. M. Infant Mortality in the United States, 1915-2017: Large Social Inequalities have Persisted for Over a Century. *Int. J. Matern. Child Health AIDS IJMA* **8**, 19–31 (2019).
4. Petersen, E. E. *et al.* Racial/Ethnic Disparities in Pregnancy-Related Deaths — United States, 2007–2016. *MMWR Morb. Mortal. Wkly. Rep.* **68**, 762–765 (2019).
5. Partridge, S., Balayla, J., Holcroft, C. & Abenhaim, H. Inadequate Prenatal Care Utilization and Risks of Infant Mortality and Poor Birth Outcome: A Retrospective Analysis of 28,729,765 U.S. Deliveries over 8 Years. *Am. J. Perinatol.* **29**, 787–794 (2012).
6. Pehl, A. F. & Howell, J. D. The evolution of prenatal care delivery guidelines in the United States. *Am. J. Obstet. Gynecol.* **224**, 339–347 (2021).
7. *Guidelines for perinatal care.* (American Academy of Pediatrics ; The American College of Obstetricians and Gynecologists, 2017).
8. Novick, G. Women’s Experience of Prenatal Care: An Integrative Review. *J. Midwifery Womens Health* **54**, 226–237 (2009).
9. Cunningham, S. D. *et al.* Group Medical Care: A Systematic Review of Health Service Performance. *Int. J. Environ. Res. Public. Health* **18**, 12726 (2021).
10. Centering Healthcare Institute. What We Do. <https://centeringhealthcare.org/what-we-do>.
11. Rising, S. Centering Pregnancy An Interdisciplinary Model of Empowerment. *J. Nurse. Midwifery* **43**, 46–54 (1998).
12. Schindler Rising, S., Kennedy, H. P. & Klima, C. S. Redesigning prenatal care through CenteringPregnancy. *J. Midwifery Womens Health* **49**, 398–404 (2004).
13. Centering Healthcare Institute. *CenteringPregnancy Facilitator’s Guide.* (2017).
14. Carter, E. B. *et al.* Group Prenatal Care Compared With Traditional Prenatal Care: A Systematic Review and Meta-analysis. *Obstet. Gynecol.* **128**, 551–561 (2016).

15. Ickovics, J. R. *et al.* Group Prenatal Care and Perinatal Outcomes: A Randomized Controlled Trial. *Obstet. Gynecol.* **110**, 330–339 (2007).
16. Jafari, F., Eftekhar, H., Fotouhi, A., Mohammad, K. & Hantoushzadeh, S. Comparison of Maternal and Neonatal Outcomes of Group Versus Individual Prenatal Care: A New Experience in Iran. *Health Care Women Int.* **31**, 571–584 (2010).
17. Cunningham, S. D. *et al.* Group Prenatal Care Reduces Risk of Preterm Birth and Low Birth Weight: A Matched Cohort Study. *J. Womens Health* **28**, 17–22 (2019).
18. Crockett, A. H. *et al.* Effects of a Multi-site Expansion of Group Prenatal Care on Birth Outcomes. *Matern. Child Health J.* **23**, 1424–1433 (2019).
19. Heberlein, E. C., Smith, J. C., LaBoy, A., Britt, J. & Crockett, A. Birth Outcomes for Medically High-Risk Pregnancies: Comparing Group to Individual Prenatal Care. *Am. J. Perinatol.* a-1682-2704 (2021) doi:10.1055/a-1682-2704.
20. Lewis, J. B. *et al.* Group prenatal care and improved birth outcomes: Results from a type 1 hybrid effectiveness-implementation study. *Prev. Med.* **153**, 106853 (2021).
21. Catling, C. J. *et al.* Group versus conventional antenatal care for women. *Cochrane Database Syst. Rev.* **2017**, (2015).
22. Liu, Y., Wang, Y., Wu, Y., Chen, X. & Bai, J. Effectiveness of the CenteringPregnancy program on maternal and birth outcomes: A systematic review and meta-analysis. *Int. J. Nurs. Stud.* **120**, 103981 (2021).
23. Ickovics, J. R. *et al.* Cluster Randomized Controlled Trial of Group Prenatal Care: Perinatal Outcomes Among Adolescents in New York City Health Centers. *Am. J. Public Health* **106**, 359–365 (2016).
24. Crockett, A. H. *et al.* Group versus traditional prenatal care for improving racial equity in preterm birth and low birthweight: the Cradle randomized clinical trial study [Manuscript submitted for publication]. (2022).
25. Weber Yorga, K. D. & Sheeder, J. L. Which Pregnant Adolescents Would be Interested in Group-Based Care, and Why? *J. Pediatr. Adolesc. Gynecol.* **28**, 508–515 (2015).
26. Wagijo, M. R. *et al.* CenteringPregnancy in the Netherlands: Who engages, who doesn't, and why. *Birth* **49**, 329–340 (2022).
27. McDonald, S. D. *et al.* Why Are Half of Women Interested in Participating in Group Prenatal Care? *Matern. Child Health J.* **20**, 97–105 (2016).
28. Cunningham, S. D. *et al.* Group Prenatal Care Attendance: Determinants and Relationship with Care Satisfaction. *Matern. Child Health J.* **21**, 770–776 (2017).

29. Earnshaw, V. A. *et al.* Exploring Group Composition among Young, Urban Women of Color in Prenatal Care: Implications for Satisfaction, Engagement, and Group Attendance. *Womens Health Issues* **26**, 110–115 (2016).
30. Francis, E. *et al.* Group Prenatal Care Attendance and Women’s Characteristics Associated with Low Attendance: Results from Centering and Racial Disparities (CRADLE Study). *Matern. Child Health J.* **23**, 1371–1381 (2019).
31. Berman, R., Weber Yorga, K. & Sheeder, J. Intention to Participate in Group Prenatal Care: Moving Beyond Yes or No. *Health Promot. Pract.* **21**, 123–132 (2020).
32. Creswell, J. W. & Plano Clark, V. L. *Designing and conducting mixed methods research.* (SAGE, 2018).
33. Crockett, A. H. *et al.* Group vs traditional prenatal care for improving racial equity in preterm birth and low birthweight: the Centering and Racial Disparities randomized clinical trial study. *Am. J. Obstet. Gynecol.* S0002937822007347 (2022) doi:10.1016/j.ajog.2022.06.066.
34. Chen, L. *et al.* Centering and Racial Disparities (CRADLE study): rationale and design of a randomized controlled trial of centeringpregnancy and birth outcomes. *BMC Pregnancy Childbirth* **17**, 118 (2017).
35. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Survey Questionnaire. *Centers for Disease Control and Prevention*
<https://www.cdc.gov/prams/Questionnaire.htm>.
36. Radloff, L. S. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Appl. Psychol. Meas.* **1**, 385–401 (1977).
37. Guardino, Christine M. & Schetter, Christine Dunkel. Understanding Pregnancy Anxiety: Concepts, Correlates, and Consequences. *Zero Three* **34**, 12–21 (2014).
38. Lobel, M. *et al.* Pregnancy-specific stress, prenatal health behaviors, and birth outcomes. *Health Psychol.* **27**, 604–615 (2008).
39. Maternal, Child and Adolescent Health Programs. The Los Angeles Mommy & Baby Project. *Publichealth.lacounty.gov*
http://publichealth.lacounty.gov/mch/lamb/Survey/2016Survey/2016LAMB_Eng.pdf (2016).
40. Carrion, B. V. *et al.* Housing Instability and Birth Weight among Young Urban Mothers. *J. Urban Health* **92**, 1–9 (2015).
41. Blumberg, S. J., Bialostosky, K., Hamilton, W. L. & Briefel, R. R. The effectiveness of a short form of the Household Food Security Scale. *Am. J. Public Health* **89**, 1231–1234 (1999).

42. Centers for Disease Control and Prevention. PRAMS Questionnaires. <http://www.cdc.gov/prams/Questionnaire.htm> (2014).
43. Williams, D. R., Yan Yu, Jackson, J. S. & Anderson, N. B. Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *J. Health Psychol.* **2**, 335–351 (1997).
44. Kotelchuck, M. An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *Am. J. Public Health* **84**, 1414–1420 (1994).
45. Braun, V. & Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**, 77–101 (2006).
46. Grand-Guillaume-Perrenoud, J. A., Origlia, P. & Cignacco, E. Barriers and facilitators of maternal healthcare utilisation in the perinatal period among women with social disadvantage: A theory-guided systematic review. *Midwifery* **105**, 103237 (2022).
47. Heberlein, E. C. *et al.* Qualitative Comparison of Women’s Perspectives on the Functions and Benefits of Group and Individual Prenatal Care. *J. Midwifery Womens Health* **61**, 224–234 (2016).
48. Kennedy, H. P. *et al.* “I Wasn’t Alone”-A Study of Group Prenatal Care in the Military. *J. Midwifery Womens Health* **54**, 176–183 (2009).
49. Lindsay, S. Five Approaches to Qualitative Comparison Groups in Health Research: A Scoping Review. *Qual. Health Res.* **29**, 455–468 (2019).
50. Peahl, A. F., Turrentine, M., Barfield, W., Blackwell, S. C. & Zahn, C. M. Michigan Plan for Appropriate Tailored Healthcare in Pregnancy Prenatal Care Recommendations: A Practical Guide for Maternity Care Clinicians. *J. Womens Health* **31**, 917–925 (2022).
51. Megregian, M., Emeis, C. & Nieuwenhuijze, M. The Impact of Shared Decision-Making in Perinatal Care: A Scoping Review. *J. Midwifery Womens Health* **65**, 777–788 (2020).

Tables and Figures

Figure 5.1 Essential elements of effective CenteringPregnancy and discussion topics
Thirteen essential elements
<ol style="list-style-type: none"> 14. Health assessment occurs within the group space. 15. Women are involved in self-care activities. 16. A facilitative leadership style is used. 17. Each session has an overall plan. 18. Attention is given to the core content; emphasis may vary. 19. There is stability of group leadership. 20. Group conduct honors the contribution of each member. 21. The group is conducted in a circle. 22. Group composition is stable, but not rigid. 23. Group size is optimal to promote the process. 24. Involvement of family support people is optional. 25. Opportunity for socialization within the group is provided. 26. There is ongoing evaluation of outcomes.
Non-exclusive list of CenteringPregnancy discussion topics
<ul style="list-style-type: none"> • Body changes during pregnancy • Food and other things to avoid while pregnant (e.g. smoking, alcohol and drug use) • Nutrition, exercise, and oral health • Fetal development • Stress management and relaxation • Intimate partner violence and abuse • Family adjustment and preparing siblings for baby • Preterm labor • Signs of early labor • Labor planning, decisions and coping with labor pain • Infant feeding • Family planning and safe sex • Parenting, bonding with baby, soothing and providing comfort • Developmental milestones and newborn safety • Perinatal mood disorders

Figure 5.2 Abbreviated semi-structured interview guide questions	
Individual Prenatal Care	Group Prenatal Care
What were people doing while waiting for your appointment?	What were people doing in the circle while waiting before or after their MAT time?
What was the most meaningful or important part of your appointment for you?	What about this session helped you with participating in your own assessment? What about this session made participating in your own assessment hard?
What does your provider do to engage you in your prenatal care?	How was your one-on-one time with the provider during MAT time?
What information or advice did your provider share with you?	What did the facilitator or participants do that encouraged participation/talking? What was done that discouraged participation/talking?
Did anyone attend your appointment with you? How did your provider involve them during your visit?	What ways were people sharing within the group?

How would you describe the level of trust between you and your provider?	Were group members helping each other?
	How would you describe the level of trust in the group session?

Table 5.1 Characteristics of patients assigned to group prenatal care

Participant Characteristics (n=1068)	n (%)
Sociodemographic Characteristics	
Age (Mean ± SD)	25.25 ± 5.42
Race and Ethnicity	
Non-Hispanic Black	435 (40.73%)
Hispanic	236 (22.10%)
Non-Hispanic White	382 (35.77%)
“other” race	15 (1.40%)
Nativity	
Born in the US	878 (82.21%)
Born outside the US	181 (16.95%)
Missing	9 (0.84%)
Language	
English	887 (83.05%)
Spanish	164 (15.36%)
Missing	17 (1.59%)
Relationship Status	
Married	448 (41.95%)
In a committed dating relationship or engaged	212 (19.85%)
Single or Other	225 (21.07%)
Missing	183 (17.13%)
Educational Attainment	
Less than high school	255 (23.88%)
High school	566 (53.00%)
Above High school	207 (19.38%)
Missing	40 (3.75%)
Household Income	
<10,000	222 (20.79%)
10,000-19,999	310 (29.03%)
≥20,000	190 (17.79%)
Missing	346 (32.40%)
Enrolled in School	
Yes	241 (22.57%)
No	755 (70.69%)
Missing	72 (6.74%)
Employment	
Working full time	345 (32.30%)
Working part time	189 (17.70%)
Unemployed	459 (42.98%)
Missing	75 (7.02%)
Health Insurance	
Had in the past year	513 (48.03%)
Did not have in the past year	434 (40.64%)
Missing	121 (11.33%)
Parity	
Nulliparous	475 (44.48%)
Primiparous/Multiparous	593 (55.52%)
Pregnancy Intension	
Unintended	352 (32.96%)
Intended	678 (63.48%)

Missing	38 (3.56%)
Feelings about Pregnancy	
Happy	630 (58.99%)
Unhappy	103 (9.64%)
Not sure of feelings	323 (30.24%)
Missing	12 (1.12%)
Psychosocial Characteristics	
Symptoms of Depression (CES-D)	
Not of clinical concern (<12)	683 (63.95%)
Of clinical concern (≥ 12)	294 (27.53%)
Missing	91 (8.52%)
Pregnancy-Specific Anxiety	
Below average	195 (18.26%)
Average	703 (65.82%)
Above average	148 (13.86%)
Missing	22 (2.06%)
Prenatal Distress (NUPDQ)	
Below average	161 (15.07%)
Average	673 (63.01%)
Above average	163 (15.26%)
Missing	71 (6.65%)
Perceived Stress (PSS)	
Below average	172 (16.10%)
Average	728 (68.16%)
Above average	125 (11.70%)
Missing	43 (4.03%)
Perceived Neighborhood Safety	
Below average	166 (15.54%)
Average	529 (49.53%)
Above average	245 (22.94%)
Missing	128 (11.99%)
Housing Instability ^a	
<2 moves during pregnancy	770 (72.10%)
≥ 2 moves during pregnancy	118 (11.05%)
Missing	180 (16.85%)
Housing issues During Pregnancy ^a	
<2 housing issues	810 (75.84%)
≥ 2 housing issues	109 (10.21%)
Missing	149 (13.95%)
Food Insecurity	
Secure	588 (55.06%)
Marginally secure	152 (14.23%)
Insecure	237 (22.19%)
Missing	91 (8.52%)
Number of Life Stressors in Pregnancy ^a	
<2 life stressors	674 (63.11%)
≥ 2 life stressors	244 (22.85%)
Missing	150 (14.04%)
Everyday Discrimination Scale (Mean \pm SD)	1.37 \pm 0.52
Missing	28 (2.62%)
Discrimination in Prenatal Care ^a	
Did not perceive discrimination	824 (77.15%)
Perceived discrimination	97 (9.08%)
Missing	147 (13.76%)
Family Support During Pregnancy	
Lower support (mean score of <4)	173 (16.20%)

Higher support (mean score of ≥ 4)	699 (65.45%)
Missing	196 (18.35%)
Baby Fathers Support During Pregnancy ^a	
Lower support (mean score of <3)	321 (30.06%)
Higher support (mean score of ≥ 3)	565 (52.90%)
Missing	182 (17.04%)
Health and Health Behavior	
Body Mass Index (BMI) at Initial Visit	
Underweight	38 (3.56%)
Healthy	336 (31.46%)
Overweight	262 (24.53%)
Obese	432 (40.45%)
Gestational Diabetes Diagnosis	
No	990 (92.70%)
Yes	78 (7.30%)
Chronic Hypertension Diagnosis	
No	953 (89.23%)
Yes	115 (10.77%)
Gestational Hypertension Diagnosis	
No	893 (83.61%)
Yes	175 (16.39%)
Cigarette Smoking during pregnancy	
None	691 (64.70%)
Smoked in 3 moths prior but quit	174 (16.29%)
Any	168 (15.73%)
Missing	35 (3.28%)
Alcohol Use during pregnancy	
None	991 (92.79%)
Any	45 (4.21%)
Missing	32 (3.00%)
Marijuana Use during pregnancy	
None	984 (92.13%)
Any	50 (4.68%)
Missing	34 (3.18%)
Number of Ultrasounds received	
<3 ultrasounds	386 (36.14%)
≥ 3 ultrasounds	682 (65.86%)
Number of Auxiliary services received ^a	
No auxiliary service	356 (33.33%)
≥ 1 auxiliary service	612 (57.30%)
Missing	100 (9.36%)

^a Measured in third trimester

Abbreviations: SD, Standard deviation; BMI, body mass index;

Figure 5.3 Participant Session Attendance and Proportion Eligible

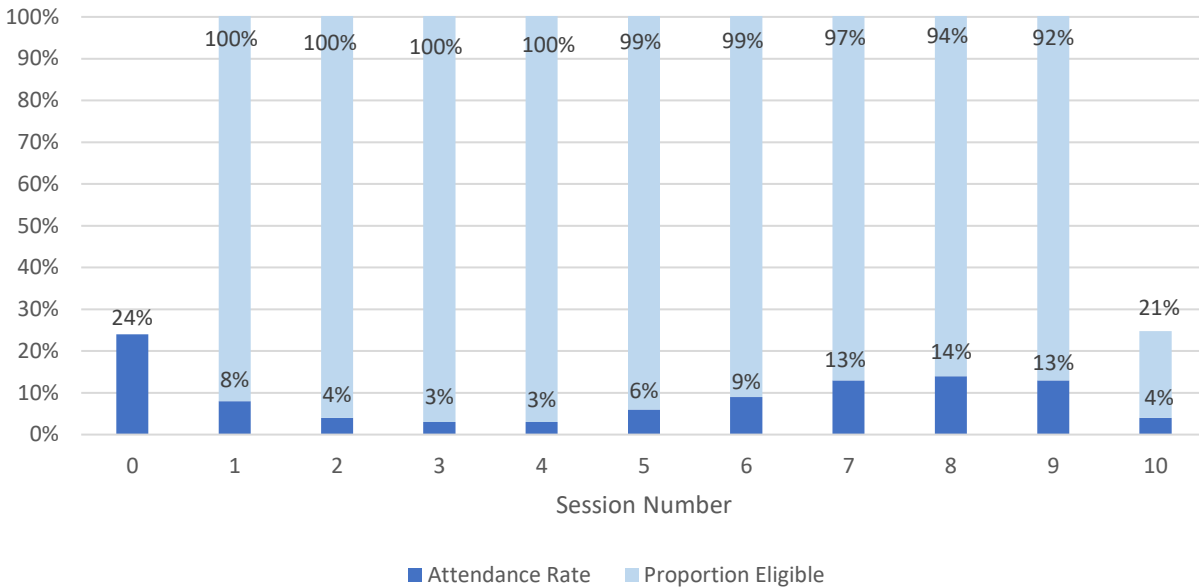


Table 5.2 Count Model: Likelihood of Group Prenatal Care Session Attendance

Participant Characteristics	Crude		Adjusted ^b	
	Beta (SE)	P value	Beta (SE)	P value
Sociodemographic Characteristics				
Age	0.00 (0.00)	0.0632	0.01 (0.00)	0.0310
Race and Ethnicity				
Non-Hispanic Black	0.04 (0.03)	0.2584	0.04 (0.03)	0.2116
Hispanic	0.05 (0.04)	0.1464	0.06 (0.04)	0.0835
Non-Hispanic White	ref		ref	
“other” race	0.19 (0.11)	0.0940	0.17 (0.11)	0.1387
Nativity				
Born in the US	ref		ref	
Born outside the US	0.10 (0.04)	0.0029	0.11 (0.04)	0.0022
Language				
English	ref		ref	
Spanish	0.04 (0.04)	0.2668	0.05 (0.04)	0.2255
Relationship Status				
Married	ref		ref	
In a committed dating relationship or engaged	-0.10 (0.04)	0.0041	-0.09 (0.04)	0.0064
Single or Other	-0.05 (0.04)	0.2337	-0.04 (0.04)	0.3212
Educational Attainment				
Less than high school	-0.13 (0.04)	0.0027	-0.13 (0.04)	0.0024
High school	-0.02 (0.04)	0.5077	-0.03 (0.04)	0.3706
Above High school	ref		ref	
Household Income				
<10,000	-0.09 (0.05)	0.0488	-0.09 (0.05)	0.0354
10,000-19,999	-0.7 (0.04)	0.1015	-0.06 (0.04)	0.1698
≥20,000	ref		ref	
Enrolled in School				
Yes	ref		ref	

No	0.04 (0.03)	0.2442	0.05 (0.03)	0.1737
Employment				
Working full time	ref		ref	
Working part time	0.00 (0.04)	0.9322	0.01 (0.04)	0.8302
Unemployed	-0.07 (0.03)	0.0265	-0.06 (0.03)	0.0858
Health Insurance				
Had in the past year	ref		ref	
Did not have in the past year	-0.02 (0.03)	0.4430	-0.02 (0.03)	0.5251
Parity				
Nulliparous	ref		ref	
Primiparous/Multiparous	0.03 (0.03)	0.2267	0.04 (0.03)	0.2131
Pregnancy Intension				
Unintended	0.00 (0.03)	0.9738	-0.00 (0.03)	0.9239
Intended	ref		ref	
Feelings about Pregnancy				
Happy	ref		ref	
Unhappy	0.02 (0.05)	0.6473	0.01 (0.05)	0.8638
Not sure of feelings	0.09 (0.05)	0.1145	0.06 (0.05)	0.2299
Psychosocial Characteristics				
Symptoms of Depression (CES-D)				
Not of clinical concern	ref		ref	
Of clinical concern	-0.07 (0.03)	0.0303	-0.06 (0.03)	0.0610
Pregnancy-Specific Anxiety				
Below average	ref		ref	
Average	0.02 (0.04)	0.5918	0.02 (0.04)	0.5896
Above average	0.02 (0.05)	0.6423	0.02 (0.05)	0.6774
Prenatal Distress (NUPDQ)				
Below average	ref		ref	
Average	0.09 (0.04)	0.0374	0.09 (0.04)	0.0255
Above average	0.04 (0.05)	0.4004	0.06 (0.05)	0.2938
Perceived Stress (PSS)				
Below average	ref		ref	
Average	-0.01 (0.04)	0.8277	-0.00 (0.04)	0.9439
Above average	-0.06 (0.05)	0.2969	-0.07 (0.05)	0.2305
Perceived Neighborhood Safety				
Below average	0.04 (0.05)	0.3995	0.05 (0.05)	0.2711
Average	0.04 (0.04)	0.2814	0.06 (0.04)	0.1246
Above average	ref		ref	
Housing Instability				
<2 moves during pregnancy	ref		ref	
≥2 moves during pregnancy	-0.11 (0.04)	0.0177	-0.09 (0.05)	0.0339
Housing Issues During Pregnancy				
<2 housing issues	ref		ref	
≥2 housing issues	-0.14 (0.05)	0.0027	-0.13 (0.05)	0.0076
Food Security				
Secure	ref		ref	
Marginally secure	0.05 (0.04)	0.2390	0.04 (0.04)	0.3340
Insecure	-0.05 (0.04)	0.1631	-0.03 (0.04)	0.3504
Number of Life Stressors in Pregnancy				
<2 life stressors	ref		ref	
≥2 life stressors	-0.09 (0.03)	0.0090	-0.08 (0.04)	0.0178
Everyday Discrimination Scale	-0.02 (0.03)	0.5122	-0.02 (0.03)	0.5430
Discrimination in Prenatal Care				
Did not perceive discrimination	ref		ref	
Perceived discrimination	-0.05 (0.05)	0.3247	-0.03 (0.05)	0.5436

Family Support During Pregnancy				
Lower support	-0.03 (0.04)	0.4325	-0.03 (0.04)	0.5260
Higher support	ref		ref	
Baby Fathers Support During Pregnancy				
Lower support	-0.00 (0.03)	0.8436	-0.00 (0.03)	0.9647
Higher support	ref		ref	
Health and Health Behavior				
Body Mass Index (BMI) at initial visit				
Underweight	0.02 (0.08)	0.7840	0.02 (0.08)	0.8219
Healthy	ref		ref	
Overweight	-0.01 (0.04)	0.7382	-0.02 (0.03)	0.5507
Obese	-0.02 (0.03)	0.5206	-0.03 (0.03)	0.4278
Gestational diabetes				
No	ref		ref	
Yes	-0.25 (0.06)	<.0001	-0.24 (0.06)	0.0001
Chronic hypertension				
No	ref		ref	
Yes	-0.12 (0.05)	0.0171	-0.08 (0.05)	0.0930
Gestational hypertension				
No	ref		ref	
Yes	0.04 (0.04)	0.2585	0.04 (0.04)	0.3009
Cigarette smoking during pregnancy				
None	ref		ref	
Smoked in 3 months prior but quit	-0.02 (0.04)	0.5972	-0.02 (0.04)	0.5813
Any	-0.10 (0.04)	0.0154	-0.09 (0.04)	0.0376
Alcohol use during pregnancy				
None	ref		ref	
Any	-0.06 (0.07)	0.3741	-0.10 (0.07)	0.1511
Marijuana use during pregnancy				
None	ref		ref	
Any	-0.10 (0.07)	0.1387	-0.10 (0.07)	0.1476
Number of ultrasounds received				
<3 ultrasounds	ref		ref	
≥3 ultrasounds	-0.02 (0.03)	0.5900	-0.02 (0.03)	0.5892
Number of auxiliary services received				
No auxiliary service	ref		ref	
≥1 auxiliary service	0.05 (0.03)	0.0897	0.03 (0.03)	0.2776

^b Adjusted for CenteringPregnancy session eligibility

Bolding indicates significance p values <0.05

Abbreviations: SD- Standard Deviation, SE- Standard Error

Table 5.3 Zero Inflated Model: Likelihood of Attending Zero Sessions

Patient Characteristics	Crude		Adjusted ^b	
	Beta (SE)	P Value	Beta (SE)	P Value
Sociodemographic Characteristics				
Age	-0.03 (0.01)	0.0312	-0.03 (0.01)	0.0298
Race and Ethnicity				
Non-Hispanic Black	-0.01 (0.16)	0.9296	-0.02 (0.16)	0.9007
Hispanic	-0.41 (0.21)	0.0481	-0.39 (0.21)	0.0546
Non-Hispanic White	ref		ref	
“other” race	0.09 (0.59)	0.8844	0.09 (0.59)	0.8725
Nativity				
Born in the US	ref		ref	
Born outside the US	-0.38 (0.21)	0.0659	-0.37 (0.21)	0.0762
Language				

English	ref		ref	
Spanish	-0.28 (0.21)	0.1942	-0.26 (0.21)	0.2154
Relationship Status				
Married	ref		ref	
In a committed dating relationship or engaged	0.13 (0.22)	0.3586	0.13 (0.22)	0.5656
Single or Other	0.23 (0.25)	0.5512	0.22 (0.24)	0.3648
Educational Attainment				
Less than high school	0.35 (0.23)	0.1248	0.35 (0.23)	0.1299
High school	0.29 (0.20)	0.1416	0.29 (0.20)	0.1450
Above High school	ref		ref	
Household Income				
<10,000	0.19 (0.23)	0.4079	0.19 (0.24)	0.3993
10,000-19,999	-0.11 (0.23)	0.6245	-0.11 (0.23)	0.6267
≥20,000	ref		ref	
Enrolled in School				
Yes	ref		ref	
No	-0.13 (0.17)	0.4524	-0.11 (0.18)	0.5344
Employment				
Working full time	ref		ref	
Working part time	-0.39 (0.23)	0.0918	-0.38 (0.23)	0.0971
Unemployed	0.07 (0.17)	0.6755	0.07 (0.17)	0.6896
Health Insurance				
Had in the past year	ref		ref	
Did not have in the past year	-0.08 (0.15)	0.5894	-0.08 (0.15)	0.6139
Parity				
Nulliparous	0.03 (0.03)	0.2267	-0.20 (0.15)	0.1632
Primiparous/Multiparous	ref		ref	
Pregnancy Intension				
Unintended	0.07 (0.16)	0.6736	0.06 (0.16)	0.6860
Intended	ref		ref	
Feelings about Pregnancy				
Happy	ref		ref	
Unhappy	-0.33 (0.24)	0.1756	-0.31 (0.24)	0.2021
Not sure of feelings	-0.15 (0.26)	0.5445	-0.14 (0.26)	0.5902
Psychosocial Characteristics				
Symptoms of Depression (CES-D)				
Not of clinical concern	ref		ref	
Of clinical concern	0.29 (0.16)	0.0745	0.28 (0.16)	0.0822
Pregnancy-Specific Anxiety				
Below average	ref		ref	
Average	0.06 (0.19)	0.7660	0.06 (0.19)	0.7693
Above average	0.34 (0.25)	0.1783	0.34 (0.25)	0.1782
Prenatal Distress (NUPDQ)				
Below average	ref		ref	
Average	-0.02 (0.21)	0.9286	-0.01 (0.21)	0.9480
Above average	0.09 (0.26)	0.7372	0.09 (0.26)	0.7333
Perceived Stress (PSS)				
Below average	ref		ref	
Average	0.51 (0.23)	0.0231	0.53 (0.23)	0.0208
Above average	0.69 (0.29)	0.0163	0.69 (0.29)	0.0195
Perceived Neighborhood Safety				
Below average	0.31 (0.23)	0.1717	0.33 (0.23)	0.1554
Average	-0.12 (0.18)	0.5128	-0.10 (0.19)	0.5807
Above average	ref		ref	
Housing Moves During Pregnancy				

<2 moves	ref		ref	
≥2 moves	0.08 (0.25)	0.7517	0.06 (0.26)	0.8063
Housing Issues During Pregnancy				
<2 housing issues	ref		ref	
≥2 housing issues	0.28 (0.25)	0.2590	0.27 (0.25)	0.2730
Food Security				
Secure	ref		ref	
Marginally secure	-0.11 (0.23)	0.6238	-0.11 (0.23)	0.6437
Insecure	0.34 (0.18)	0.0539	0.35 (0.18)	0.0499
Number of Life Stressors in Pregnancy				
<2 life stressors	ref		ref	
≥2 life stressors	0.29 (0.19)	0.1194	0.29 (0.19)	0.1215
Everyday Discrimination Scale	0.19 (0.14)	0.1744	0.18 (0.14)	0.2000
Discrimination in Prenatal Care				
Did not perceive discrimination	ref		ref	
Perceived discrimination	0.39 (0.25)	0.1238	0.39 (0.25)	0.1256
Family support during pregnancy				
Lower support	0.28 (0.19)	0.1452	0.28 (0.19)	0.1458
Higher support	ref		ref	
Baby fathers support during pregnancy				
Lower support	-0.23 (0.18)	0.2236	-0.22 (0.19)	0.2277
Higher support	ref		ref	
Health and Health Behavior				
Body Mass Index (BMI) at initial visit				
Underweight	0.19 (0.41)	0.6490	0.21 (0.41)	0.6145
Healthy	ref		ref	
Overweight	0.33 (0.19)	0.0962	0.33 (0.19)	0.0913
Obese	0.20 (0.18)	0.2473	0.22 (0.18)	0.2284
Gestational diabetes				
No	ref		ref	
Yes	0.25 (0.27)	0.3515	0.26 (0.27)	0.3365
Chronic hypertension				
No	ref		ref	
Yes	0.39 (0.22)	0.0698	0.39 (0.22)	0.0709
Gestational hypertension				
No	ref		ref	
Yes	-0.16 (0.20)	0.4271	-0.15 (0.20)	0.4546
Cigarette smoking during pregnancy				
None	ref		ref	
Smoked in 3 months prior but quit	0.32 (0.19)	0.1009	0.31 (0.19)	0.1069
Any	0.33 (0.19)	0.0896	0.31 (0.19)	0.1187
Alcohol use during pregnancy				
None	ref		ref	
Any	0.06 (0.36)	0.8688	0.07 (0.36)	0.8471
Marijuana use during pregnancy				
None	ref		ref	
Any	0.03 (0.34)	0.9344	0.04 (0.34)	0.9050
Number of ultrasounds received				
<3 ultrasounds	-0.12 (0.15)	0.4245	-0.12 (0.15)	0.4274
≥3 ultrasounds	ref		ref	
Number of auxiliary services received				
No auxiliary service	-0.29 (0.16)	0.0775	-0.28 (0.16)	0.0918
≥1 auxiliary service	ref		ref	

^b Adjusted for CenteringPregnancy session eligibility

Bolding indicates significance p values <0.05

Abbreviations: SD- Standard Deviation, SE- Standard Error

Table 5.4 Number and trimester of qualitative interviews

	Overall	GPNC	IPNC
Participants	31	10	21
Interviews	79	30 (37.9%)	49 (62.0%)
Mean ± SD	2.52 ± 1.54	3.00 ± 1.05	2.29 ± 1.71
Range	1-6	2-5	1-6
Trimester conducted			
First Trimester (<14 weeks)	2	0	2
Second Trimester (14-27 weeks)	48	21	27
Third Trimester (>28 weeks)	29	9	20

Abbreviations: GPNC, group prenatal care; IPNC, individual prenatal care; SD, standard deviation

Table 5.5 Sociodemographic characteristics of interview participants

Sociodemographic characteristics	Overall n=31	GPNC n=10	IPNC n=21
Age (Mean ± SD)	26.66 ± 6.24	26.55 ± 5.36	26.71 ± 6.74
Race and Ethnicity			
Non- Hispanic Black	10 (32.3%)	4 (40.0%)	6 (28.6%)
Hispanic	9 (29.0%)	4 (40.0%)	5 (23.8%)
Non-Hispanic White	12 (38.7%)	2 (20.0%)	10 (47.6%)
Educational Attainment			
Less than high school	5 (16.1%)	1 (10.0%)	4 (19.1%)
High school	19 (61.3%)	5 (50.0%)	14 (66.7%)
More than high school	4 (12.9%)	1 (10.0%)	3 (14.3%)
Missing	3 (9.7%)	3 (30.0%)	0 (0.0%)
Annual household Income			
<10,000	8 (25.8%)	2 (20.9%)	6 (28.6%)
10,000-19999	8 (25.8%)	2 (20.0%)	6 (28.6%)
>=20,000	5 (16.1%)	1 (10.0%)	4 (19.1%)
Missing	10 (32.3%)	5 (50.0%)	5 (23.8%)
Relationship Status			
Married	9 (29.0%)	1 (10.0%)	8 (38.1%)
Committed dating relationship or engaged	7 (22.6%)	3 (30.0%)	4 (19.1%)
Single or other relationship	13 (41.9%)	4 (40.0%)	9 (42.9%)
Missing	2 (6.5%)	2 (20.0%)	0 (0%)
Parity			
Nulliparous	9 (29.0%)	1 (10.0%)	8 (38.1%)
Primiparous/Multiparous	22 (70.9%)	9 (90.0%)	13 (61.9%)

Abbreviations: GPNC, group prenatal care; IPNC, individual prenatal care; SD, standard deviation

Table 5.6 Interview participants prenatal care attendance

Prenatal Care Attendance	GPNC (Mean ± SD)	IPNC (Mean ± SD)
Total number of PNC visits/sessions	11.0 ± 1.8	10.7 ± 1.6
IPNC visits attended	4.5 ± 2.5	10.7 ± 1.6
GPNC sessions attended	6.0 ± 1.9	0.0 ± 0.0
Proportion of care received in GPNC	54.9 ± 15.3	0.0 ± 0.0
Adequacy of prenatal care		
Intermediate (50-79% expected visits)	0 (0%)	1 (4.8%)
Adequate (80%-109% expected visits)	4 (40.0%)	10 (47.6%)

Bolded p-values indicate statistical significance

Abbreviations: GPNC, group prenatal care ; IPNC, individual prenatal care; SD, standard deviation

Figure 5.4 Depiction of Themes by Model of Care

	Theme Summary:	CP Exemplifying Quotes:	IPNC Exemplifying Quotes:
Monitoring of Fetal Wellbeing	<p>Complete Convergence</p>	<p>"It was good. I got to hear the baby's heartbeat and she is growing." (CP patient, third trimester)</p> <p>"I love hearing the heartbeats of everyone's baby. That is really cool." (CP patient, third trimester)</p>	<p>"When I hear the baby's heartbeat because it lets me know that she is okay and that she is doing fine." (IPNC patient, third trimester)</p>
Patient-Provider Relationship	<p>Slight Divergence</p>	<p>"They do not come in there with this professional attitude like "this is my job", they come in like "we are just hanging out and we are learning about this." (CP patient, second trimester)</p> <p>I would say that the trust is completely there. I have had [provider] before, so that trust is definitely there." (CP patient, third trimester)</p>	<p>"She is really nice and gives me advice. Whenever I have concerns, she answers the questions I have." (IPNC patient, third trimester)</p> <p>"I trust her a lot. I feel like I can ask her if I have any concerns." (IPNC patient, third trimester)</p>
Engagement and Education	<p>Partial Divergence</p>	<p>"You get a lot more information in Centering, not just things learned during our discussion time but from the experiences of the other women and reply to them. I never thought of some of these questions in individual care." (CP patient, third trimester)</p> <p>"I think the games are a fun way to talk about the topics. I did not get bored... I noticed that some of the shy people became more engaged during the activities and games." (CP patient, second trimester)</p>	<p>"Just how I wanted it. I had questions and she answered them for me." (IPNC patient, third trimester)</p> <p>"Just asks me little questions to help me, how I am feeling and all that." (IPNC patient, third trimester)</p>
Trust in and Support from Peers	<p>Complete Divergence</p>	<p>"There is a high level of trust in here. I feel like we can discuss anything without worry of feeling embarrassed. There is no judgement in this group at all." (CP patient, third trimester)</p> <p>"We all think at times when we are going through pregnancy, we are the only ones going through it. Being in a group and saying and hearing "I deal with that." Is humbling and makes you feel better." (CP patient, second trimester)</p>	<p>-----</p>
Involvement of Support Persons	<p>Slight Divergence</p>	<p>"Another girl brought her partner so that was a good thing to have the dads interacting and stuff and then they asked questions that you know moms would not think to ask." (CP patient, third trimester)</p>	<p>"Sometimes I don't remember everything and then that is why I have him, so he can ask questions as well." (IPNC patient, third trimester)</p>

● CenteringPregnancy (CP) ● Individual Prenatal Care (IPNC)

CHAPTER SIX

MANUSCRIPT THREE

Title: Investigating discussions of health in online forums during pregnancy through text mining

Abstract

Background

A large majority of birthing persons seek out health information online during pregnancy. Information found online can influence pregnancy decision making, at times may be consulted in lieu of a healthcare provider. Online pregnancy forums provide a space for peers to both seek and share information and support. Few studies have examined the content generated by pregnant persons in online pregnancy forums, in the form of user posts and responses.

Objective

Utilize text mining methods to describe topics discussed in online pregnancy forums, to better understand to what degree health related topics are discussed among online peer communities during pregnancy.

Methods

Data from three active online pregnancy forums (January 2021 to December 2021) was scraped. Threads (initial and response posts; n=36,985) were processed and Latent Dirichlet Allocation (LDA) topic modeling performed. Models with between 10-80 topics were evaluated and the 50-topic model determined to best fit the data based on the interpretability of word clusters. Topics were interpreted by two independent coders, and it was determined whether each was health related.

Results

Forty-six percent of threads concerned health related topics. The largest health-related topic categories were fertility (10.2%), planning for delivery (7.6%), miscarriage (6.3%) and pregnancy symptoms (4.7%). Non-health related topics contributed to 51% of threads and included name and product recommendations, as well as social exchanges.

Discussion

Pregnant persons discuss health related topics in online forums. Dominant health related topics may represent unmet information needs offline. The accuracy of health-related content provided in online forums is not well understood and requires further analysis to determine whether reliance on this information for decision making in pregnancy may cause harm.

Keywords: pregnancy, online forums, information-seeking

Introduction

Pregnant persons are increasingly turning to the internet for health information. Over 70% of people seek health information online during pregnancy.¹ People are more likely to seek digital health information when pregnant than during other periods, with most pregnant persons searching for information online at least once a month.^{1,2} The internet can often serve as a convenient and accessible source of information and support. Pregnant persons report seeking digital health information before, after, and in between prenatal care appointments.³ Pregnant persons will refer to the internet prior to contacting their health provider, as they do not want to bother their provider, do not want to waste their providers time with numerous or silly questions, want to be informed prior to speaking with their provider or because they are unable get in contact with their provider in a timely manner.^{3,4,5} Pregnant persons also refer to the internet following prenatal care appointments, to clarify the information they received, due to dissatisfaction with information received or to confirm knowledge and reinforce decisions.^{3,6}

The infrequent schedule of prenatal care visits particularly in early pregnancy and short visit length contributes to pregnant persons seeking health information online.³

More than just providing reassurance, health information found online influences decision making in pregnancy. More than two thirds of pregnant persons report using online information to make decisions about pregnancy.⁷ Information online has been found to affect pregnancy decisions related to vaccination uptake, physical activity and nutrition, choice of birth setting, medication use, and lifestyle.^{8,9,10,11,12} There is concern for the accuracy of health-related information on the internet. Previous review of pregnancy information on popular sites found most but not all information to be accurate.¹³ While a majority of pregnant persons search for health information online, nearly 30% of pregnant persons report they do discuss the information they find with their health care provider.¹³

One form of pregnancy content available online are online discussion forums targeting pregnant persons. Online forums are interactive often with a tree like structure organized by theme and subtheme from which users' initial posts and responses branch. These forums can typically be viewed by the public but require the creation of an account to post. Online pregnancy forums are sought out for experiential knowledge, to normalize experiences in pregnancy and to express emotions, worries or needs not met offline.^{14,15} Pregnant persons are likely to come into contact with contact with online forums. Online pregnancy information is most frequently sought through search engines from which natural language queries are likely to generate links to online discussion forums.^{16,17} Concern for the quality of health information online during pregnancy may be amplified when considering online forums, which are even less likely to receive oversight my medical experts. Quality evaluation of responses to health-related

posts made to online pregnancy forums suggest a little over half of posts to be accurate, while 21% of responses contain erroneous, misleading or incomplete information.¹⁴

Given the influence of online sources on pregnancy decisions, and the popularity of online discussion forums, it is important to understand what information is discussed in these spaces. The majority of research investigating information seeking in online discussion forums has employed traditional research methods such as survey and interview,² but self-report may differ from actual patterns of use. Alternatively, information seeking can be analyzed through examination of the user generated content in online forums. The vast quantity of readily available user generated content can provide rich and unprompted data for analysis.¹⁸ Few studies have taken advantage of this dataset to study discussions taking place in online pregnancy forums broadly rather than among particular subcategories of users (e.g. adolescents, postpartum depression, breastfeeding). Two of these three studies have utilized qualitative methods to analyze a relatively small subset of posts.^{6,19} The labor-intensive nature of qualitative research can limit its scalability for “big data”. Text mining is an automatic or semiautomatic tool for extracting patterns from unstructured text information. Through algorithms, text mining approach can efficiently analyze large volumes of data.²⁰

To date we are aware of a single study that has applied text mining methods to the examination of discussions in online pregnancy forums, investigating the topics of posts made to “birth club” sections of Whattoexpect.com’s online forum.²¹ The present study seeks to build upon Wexler et al., (2019) by applying the text mining method of Latent Dirichlet Allocation (LDA) topic modeling²² to posts made in online pregnancy discussion forums over a year period, with the objective of describing what topics are discussed and further identifying whether topics of discussion are health related. By not limiting our analysis to a specific section of the

forum, we are able to map the overall proportion of posts made to online pregnancy forums in each topic area.

Methods

Design and Sample

The current study used publicly available data from three online pregnancy communities. Active online pregnancy forums were identified by searching the term “online pregnancy discussion forum or community” in Google. Sites in the first page of results were assessed using a web analytics tool (Alexa.com). Search engines are a common manner for pregnant persons to seek out health information online and the first page of results represents sites ranked highly by the google search engine which they are more likely to encounter. Through the Alexa platform we determined total site visits, global rank and rank in the United States (US). The three highest ranked sites among US users were selected as the sampling frame for our study. This included online communities hosed at Babycenter.com, Thebump.com and Whattoexpect.com.

Data extraction was conducted using the Sprinklr Inc. social media listening platform. We narrowed collection to a one-year period (January-December 2021). For forums hosted by Whattoexpect.com and thebump.com, posts made in 2021 were extracted. Due to the website properties of Babycenter.com, we were unable to extract all posts for 2021 at once, therefore pregnancy groups were sorted by popularity and posts made during 2021 to groups within the first 25 pages of results (12 groups displayed per page) were extracted. While two of these forums allow users to from private groups, only publicly viewable posts were included within our dataset. Thread title, message, date and time posted were scraped.

Ethics

All data used in the present study was publicly available. Research was not considered to include human subjects and was therefore exempt from Institutional Review Board review. Additionally, study methods were in compliance with websites terms of use.

Latent Dirichlet Allocation

In text mining, a unit of textual data is referred to as a document and the collection of documents as a corpus. LDA is an unsupervised Bayesian probabilistic modeling method, guided by two principles: each document is treated as a mixture of topics and each topic as a mixture of words.²² The order of words is viewed as negligible and documents modeled as a “bag of words”. By analyzing word co-occurrence, a succinct overview of the themes within the corpus is generated. Both word-topic probabilities (the estimated probability that a word is generated by a certain topic) and document-topic probabilities (the estimated probability that a topic is generated in a certain document) are produced.

Analysis took place over five stages: 1) gathering of text data, 2) processing of text data, 3) generation of a Document Term Matrix (DTM), 4) Selection of k topics and 5) implementation and interpretation of LDA model with K topics (Table 1).²³ Data processing and analysis was conducted in R version 4.2.3. Initial posts and subsequent response posts were combined and the thread considered the unit of analysis (document). Text processing was performed to clean data and transform documents into a form in which data could be extracted. Text processing was performed using the “tm” package in R. Document text was converted to lowercase and punctuation, numbers and special symbols removed. Stop words, common words in the English language with little isolated meaning (e.g. is, a, the) were eliminated and documents were tokenized, divided into meaningful tokens (words). Duplicate threads were removed. Each document was stored in a DTM; a matrix in which each row represents one

document (thread), each column represents one term (word) and each cell value contains the frequency with which that term appeared in the document.²³

Topic modeling was performed using the “topicmodels” package in R. To identify the appropriate number of topics (k) we first estimated a k=10 topic model and then sequentially increased the number of topics being modeled up to k=80 topics. Model interpretability was compared and a model with distinct enough word clusters to assign labels but that did not produce overly similar topics was selected. When a model with k topics was selected, the 15 words with the highest word-topic probabilities and the 15 threads with the highest document-topic probabilities were extracted for review. Two researchers independently inspected the top words and most representative threads assigning each topic a label and indicating whether the topic was health related. In accordance with the World Health Organizations definition of health,²⁴ we define health related as concerning aspects of physical, mental and social wellbeing. The two researchers met, and topic labels were reviewed, any disagreements in topic labeling or health designation was discussed and threads reviewed until consensus was reached. Labeled topics were then organized into categories based on topic similarity. The “LDavis” package in R was used to obtain the percentage of tokens (i.e. words) contributing to each topic.

Results

For the one-year period, we collected 314,929 posts; 66.9% of posts were from babycenter.com (n=210,853), 26.8% thebumb.com (n=84,334), 6.3% whattoexpect.com (n=19,742). Initial and response posts were combined into threads and duplicate threads removed, resulting in 36,985 unique threads.

Based on inspection of word cluster interpretability for models with 10 to 80 topics, a model with k=50 topics was selected. Following manual review, four topics were excluded, as

they were deemed not to represent semantically coherent topics. This resulted in 46 topics total. Word clusters and topic labels for the 46 topics derived by LDA topic modeling are displayed in Table 1. Where usernames were included in word clusters they were substituted by the next highest word-topic probability in the visual.

Topics were further categorized as related to health or not related to health and where applicable categorized together with similar topics. Sixteen topics were deemed to be health related, while the remaining 30 were deemed not to be health related. While resulting in almost twice as many topics, the percentage of threads characterized by health and non-health related topics was more similar, 45.6% of threads comprised health related topics and 51.3% non-health related. A summary of health and non-health related topic categories is displayed in Figure 2.

Health Related Topics

Fertility was the most common category of health-related topics, representing 10.2% of threads. The fertility category was comprised of two topics: “Trying to conceive and monitoring fertility” and “Infertility treatments”, threads within these topics regarded tracking ovulation, basal body temperature and menstrual cycles in an effort to conceive; and treatments for infertility including in vitro fertilization (IVF) and intrauterine insemination (IUI). The second largest category of health-related topics, planning for delivery represented 7.6% of threads. Planning for delivery was comprised of three topics: “Preparation and support for natural birth”, “The labor and delivery experience” and “VBAC and prevention of preterm birth”. Threads within these topics concerned advocating and preparing for a natural birth, doulas, and birth classes; cervical checks, dilation, contractions, pain and induction; and the desire for vaginal birth after cesarean (VBAC) and measures to prevent preterm birth (progesterone and cerclage). The third largest category of health-related topics was Miscarriage, which accounted for 6.3% of threads. The miscarriage

category included topics of “Bleeding and fear of miscarriage” and “hCG levels and chemical pregnancy” these topics regarded bleeding, spotting, fear of pregnancy loss and subchronic hematoma (SCH); and levels of the Human Chorionic Gonadotropin (hCG) hormone and suspected chemical pregnancy.

Other categories of health-related topics included symptoms (4.7%), pregnancy ambivalence (3.9%), growth and appointments (3.8%), Complications (3.2%), vaccination (2%), infant feeding (1.5%) and lifestyle (1.3%). The symptoms category included two topics “Pregnancy Symptoms” and “Treatment of nausea and vomiting” which concerned discomforts of pregnancy (eg. nausea, fatigue, back and pelvic floor pain); and treatments for severe nausea and vomiting, including medication, combinations of medication and IV fluids. Threads within the pregnancy ambivalence category and “Single parenthood or abortion” topic regarded unplanned pregnancy, troubled relationships with the non-birthing parent, depression, and consideration of abortion. The growth and appointments category and “Updates on appointment and fetal growth” topic concerned recent prenatal care appointments, tests or monitoring received and updates on fetal growth. Threads within the complications category and “Concern over testing/ scan results and weight” topic regarded noninvasive prenatal testing (NIPT), low fetal fraction in higher weight individuals, ultrasound findings and suspected fetal complications. The vaccination category and “Safety of vaccination” topic concerned the safety and benefits of the Corona Virus, tetanus, diphtheria, and pertussis (Tdap), measles, mumps, and rubella (MMR) vaccines while pregnant and breastfeeding. Threads within the “infant feeding” category and topic regarded breastfeeding, formula, bottles, pumping, increasing milk supply and challenges of infant feeding. The lifestyle category and “Exercise and health goals” topic concerned health intentions including forms of exercise, calorie tracking, hydration, and mindfulness.

Non-Health Related Topics

The most common category of non-health related topics was naming baby which consisted of multiple topics concerned with “Name recommendations”. Twenty-one of the total 46 topics and 32.9% of threads focused on selection of baby names. Other categories of non-health related topics included social exchanges (14.7%) and product recommendations (3.7%). Threads within the social exchange category focused on making and continuing social connections following delivery, celebrating pregnancy milestones (e.g. positive pregnancy tests, birth or six months), viewing pregnancy tests, making guesses about the sex of the baby and recipe suggestions. While the topic of “Meal and recipe suggestions” might initially be considered health-related, it was not deemed to pertain to health as threads primarily consisted of sharing recipes or daily meals without health context. The product recommendation category consisted of two topics “Maternity clothing and packing for the hospital” and “product recommendations for newborns”, these threads regarded the selection of maternity clothes, bras and products to bring for delivery, and selection of newborn products including diapers, car seats, cribs, strollers and tubs.

Discussion

The objective of the current study was to systematically describe discussion topics in popular online pregnancy forums, particularly those related to health using the text mining approach of LDA topic modeling. Our results suggest that in addition to social support, pregnant persons are engaging with online peer communities to discuss their health. While more than half of threads focused on baby name, social exchanges and product recommendations, 45.6% of discussion threads concerned health related topics. The most common health-related topic was fertility including tracking ovulation as a component of trying to conceive and seeking treatment

for infertility including assisted reproductive technology (ART). Other common health-related topics of discussion included planning for delivery, miscarriage and symptoms of pregnancy.

Our findings are consistent with much of the previous research examining online pregnancy forum posts. While these studies tended to assess topics by pregnancy stage, we selected not to do so in favor of describing the entirety of posts made over a year long period rather than the subset made to dated groups (i.e birth month boards). Despite this discrepancy, similar health-related topics emerged including miscarriage (first trimester), pregnancy symptoms (second trimester), labor and delivery (third trimester) and lab tests (across pregnancy).⁶¹⁹²¹ One distinction from previous studies is that we did not identify topics relating to newborn care, such as newborn sleep routine or newborn health issues which have previously been shown to be popular topics of information seeking.²¹¹⁹ It is possible that in viewing the perinatal period as a whole, these topics were not prevalent enough to result as a distinct topic.

The current study findings also share commonalities with pregnant persons self-reported information seeking online. Previous work suggests pregnant persons most frequently report interest in fetal development, nutrition in pregnancy, medication in pregnancy and pregnancy complications and that Infertility is the most commonly raised topic of pre-pregnancy and breastfeeding of the postpartum period.^{2,25,26} Though overlapping some topics self-reported to be of interest did not emerge as topics within online forum posts. This is consistent with comparisons made by previous analysis of user generated content in online forums and may suggest some topics are addressed via other online sources (e.g. fetal development via web apps) or implications of methodical differences such as sampling or the role of recall bias.²¹

Previous research suggests pregnant persons are motivated to seek out information online to supplement deficiencies offline.^{3,14} Prominent topics of discussion online may represent

information gaps offline, in the patient education provided in perinatal care. While perinatal care should be patient and family centered, responsive to individual patient needs, preferences and values, guidelines for patient education in perinatal care, such as those from the American Academy of Pediatrics and the American College of Obstetrics and Gynecology or the University of Michigan, Michigan Medicine Quality Department provide a window of what information should be provided to each patient.^{27,28} In a comparison of the health-related topics that emerged in our LDA analysis of online pregnancy forums with patient education guidelines (Figure 3), the absence of several topics is apparent. Topic categories of fertility, pregnancy ambivalence and miscarriage appear are not included within these expectations for perinatal care. Some of this discrepancy may be explained by the scope of perinatal care, while others may indicate opportunities to better address patient's information needs in prenatal care.

While online pregnancy forums typically span from trying to conceive to postpartum and parenting, prenatal care is not initiated until pregnancy begins. Fertility issues are typically discussed with a gynecologist or family provider and referral to a fertility specialist or reproductive endourologist made. However, there are significant economic, education, insurance and citizenship disparities in access to infertility care.²⁹ Inadequate information, as well as physical and emotional stress associated with infertility may prompt persons to seek information from peers online.³⁰ Whereas fertility issues are not typically served in perinatal care, exclusion of education surrounding pregnancy options and miscarriage may represent a gap in current services.

While several medical organizations recognize counseling patients on all pregnancy options (adoption, abortion, and parenting) as an ethical obligation,^{31,32,33} at what point pregnancy options counseling should be provided is not clear.³⁴ Although the pregnancy test visit

may be an opportune time for such discussions, some patients determine their pregnancy through home tests. The initial prenatal care visit may these patients first opportunity to receive information on pregnancy options from a provider. Research suggests that although most patients feel certain about their decision upon entry to prenatal care, a not insignificant minority is interested in pregnancy options counseling at their first visit.³⁴ Miscarriages (pregnancy loss prior to 20 weeks gestation) occur in 26% of pregnancies, with 80% miscarriages occurring prior to 12 weeks gestation.³⁵ The first perinatal care visit is typically scheduled to coincide with ultrasound dating after 10 weeks gestational age,³⁶ this timing may miss opportunities for patient education on topics most salient early in pregnancy such as pregnancy options and miscarriage. In order to ensure the accuracy of information received on these subjects, inclusion in perinatal patient education may be warranted. One solution could be the early care model, in which patients are provided an hour long virtual initial visit at any gestation desired by the patient, allowing for greater education in early pregnancy.³⁷

Although other dominant health-related topics we identified in online forums are included in guidelines for patient education in perinatal care, there prevalence may indicate patients' information needs in these areas are not being meet in perinatal care. In line with previous findings of pregnant persons motivations for visiting online peer communities, topics could also indicate areas in which experiential information or normalization is sought.¹⁴ Alternative prenatal care models incorporating increased patient education or opportunities to socialize with peers, such as group preparental care could assist in fulfilling these needs offline. Group prenatal care combines peer support and facilitated education with clinical assessment in a group setting.³⁸ Newer models of group prenatal care have even incorporated integrated IT

platforms that enable patients to communicate with providers and fellow group members between sessions.³⁹

Our study has several strengths as well as limitations. Through analysis of user generated content online, our study takes advantage of the abundant naturally occurring data. The relative anonymity users experience may contribute to greater openness when discussing sensitive topics. As responses are unprompted bias introduced by researcher interaction may be reduced. Analysis of user posts may better capture users actual use as opposed to self-reported behaviors. While working with user generated content online offers advantages, disadvantages include the lack of sociodemographic information available for users. We could not determine users' race, ethnicity, gender, age, location or socioeconomic status, nor could we determine users' stage of pregnancy or parity. In our review of posts all but a few posts appeared to be from heterosexual women but in some cases, users identified themselves as a trans man or the male partner of a pregnant person. It is therefore not possible to make claims to the representativeness of these findings to other populations.

Our study is one of the first to provide a large-scale analysis of discussion in online pregnancy forums. Application of the text mining approach of LDA analysis, enabled us to organize and summarize the large volume of content generated by pregnant persons in online forums, exploring dominant themes in a manner that would not be feasible utilizing traditional qualitative methods. However, topics do not indicate all the topics discussed in forums but rather word clusters determined to have strong correlations between words. Some topics may contain multiple subtopics with related words. Topics related to sensitive or less common situations or that use a range of different words to refer to the same meaning may be less likely to be identified by LDA modeling. Designations of being related to health were determined based

upon review of the 15 keywords and most representative threads and could therefore vary in the remaining threads. Despite the wide and established use of LDA, there are not specific recommendations for best practice approaches in particular settings, for example there is not a single approach for model checking, determining the optimal number of topics to model.⁴⁰

Taken together, these findings enhance our understanding of health-related discussions taking place in online discussion forums. It is important providers recognize that the majority of their pregnant patients are seeking health information online. Patients may refer to the internet in lieu of or in addition to contacting providers. The information patient find online will likely influence their decisions in pregnancy. There is a need to promote digital health literacy among both providers and patients, enhancing the ability to search, find, understand, and evaluate health related information online.⁴¹ Providers should engage their pregnant patients in discussions about the health information they find online and guide patient toward evidenced based websites.

Future research should continue investigate the user generated data of pregnant persons online such as in online pregnancy forums, as these posts offer valuable information on the values and needs of these populations. Text mining approaches offer opportunities to engage with the vast volume of data online. The benefits of text mining approaches can be combined with the strengths of qualitative analysis through mixed methods approaches, with texting mining methods organizing data by relevance in depth qualitative analysis.³⁹ In addition to clarifying themes, further research evaluating the accuracy of peer responses and recommendations is needed, in order to better understand the quality of health information in online peer communities. In addition to application for research machine learning methods may also present solutions to quality concerns. Though in its infancy, increasingly sophisticated

machine learning techniques are being applied in the detection of misinformation in health-related content online.⁴²

Conclusion

In this study, we investigated the topics of discussion in online pregnancy forums using the text mining technique of LDA topic modeling. Forty-six topics were identified, 16 of which were related to health. Health-related topics comprised 46% of conversations. Common health related topics included fertility, planning for delivery, miscarriage, and pregnancy symptoms. Our findings suggest a large proportion of online pregnancy forum discussions are health related. Prominent health related topics in online pregnancy forums may represent unmet informational needs offline and in the patient, education provided in perinatal care. Little is known about the qualitative of health information in online pregnancy forums. It is therefore important that providers engage their patients in discussing about health information found online and that digital health literacy is encouraged. Further research on the content and quality of health information in online pregnancy forums is warranted.

References

1. Hsiao, S.-H., Hsu, H.-Y., Erickson, S. R., Lu, T.-S. & Wu, C.-H. Seeking health information online among U.S. pregnant women: findings from the 2009-2018 National Health Interview Surveys. *Women Health* **63**, 59–69 (2023).
2. Sayakhot, P. & Carolan-Olah, M. Internet use by pregnant women seeking pregnancy-related information: a systematic review. *BMC Pregnancy Childbirth* **16**, 65 (2016).
3. Lagan, B. M., Sinclair, M. & Kernohan, W. G. What Is the Impact of the Internet on Decision-Making in Pregnancy? A Global Study. *Birth* **38**, 336–345 (2011).
4. Kraschnewski, J. L. *et al.* Paging “Dr. Google”: Does Technology Fill the Gap Created by the Prenatal Care Visit Structure? Qualitative Focus Group Study With Pregnant Women. *J. Med. Internet Res.* **16**, e147 (2014).
5. Prescott, J. & Mackie, L. “You Sort of Go Down a Rabbit Hole...You’re Just Going to Keep on Searching”: A Qualitative Study of Searching Online for Pregnancy-Related Information During Pregnancy. *J. Med. Internet Res.* **19**, e194 (2017).
6. Gui, X., Chen, Y., Kou, Y., Pine, K. & Chen, Y. Investigating Support Seeking from Peers for Pregnancy in Online Health Communities. *Proc. ACM Hum.-Comput. Interact.* **1**, 1–19 (2017).
7. Lagan, B. M., Sinclair, M. & George Kernohan, W. Internet Use in Pregnancy Informs Women’s Decision Making: A Web-Based Survey. *Birth* **37**, 106–115 (2010).
8. Ford, A. J. & Alwan, N. A. Use of social networking sites and women’s decision to receive vaccinations during pregnancy: A cross-sectional study in the UK. *Vaccine* **36**, 5294–5303 (2018).
9. Huberty, J., Dinkel, D., Beets, M. W. & Coleman, J. Describing the Use of the Internet for Health, Physical Activity, and Nutrition Information in Pregnant Women. *Matern. Child Health J.* **17**, 1363–1372 (2013).
10. Hinton, L., Dumelow, C., Rowe, R. & Hollowell, J. Birthplace choices: what are the information needs of women when choosing where to give birth in England? A qualitative study using online and face to face focus groups. *BMC Pregnancy Childbirth* **18**, 12 (2018).
11. Sinclair, M., Lagan, B. M., Dolk, H. & McCullough, J. E. M. An assessment of pregnant women’s knowledge and use of the Internet for medication safety information and purchase. *J. Adv. Nurs.* **74**, 137–147 (2018).
12. Bert, F. *et al.* Pregnancy e-health: a multicenter Italian cross-sectional study on internet use and decision-making among pregnant women. *J. Epidemiol. Community Health* **67**, 1013–1018 (2013).

13. Narasimhulu, D. M., Karakash, S., Weedon, J. & Minkoff, H. Patterns of Internet Use by Pregnant Women, and Reliability of Pregnancy-Related Searches. *Matern. Child Health J.* **20**, 2502–2509 (2016).
14. Ellis, L. & Roberts, L. Exploring the use and quality of Internet discussion forums in pregnancy: A qualitative analysis. *Birth* **47**, 153–161 (2020).
15. Xie, J., He, Z., Burnett, G. & Cheng, Y. How do mothers exchange parenting-related information in online communities? A meta-synthesis. *Comput. Hum. Behav.* **115**, 106631 (2021).
16. Rodger, D. *et al.* Pregnant women’s use of information and communications technologies to access pregnancy-related health information in South Australia. *Aust. J. Prim. Health* **19**, 308 (2013).
17. Farrant, K. & Heazell, A. E. P. Online information for women and their families regarding reduced fetal movements is of variable quality, readability and accountability. *Midwifery* **34**, 72–78 (2016).
18. Holtz, P., Kronberger, N. & Wagner, W. Analyzing Internet Forums: A Practical Guide. *J. Media Psychol.* **24**, 55–66 (2012).
19. Lu, Y., Zhang, Z., Min, K., Luo, X. & He, Z. Pregnancy-Related Information Seeking in Online Health Communities: A Qualitative Study. in *Diversity, Divergence, Dialogue* (eds. Toeppe, K., Yan, H. & Chu, S. K. W.) vol. 12646 18–36 (Springer International Publishing, 2021).
20. Blei, D. M. Probabilistic topic models. *Commun. ACM* **55**, 77–84 (2012).
21. Wexler, A. *et al.* Pregnancy and health in the age of the Internet: A content analysis of online “birth club” forums. *PLOS ONE* **15**, e0230947 (2020).
22. Blei, D. M., Ng, A. Y. & Jordan, M. I. Latent Dirichlet Allocation. *J. Mach. Learn. Res.* **3** 993–1022 (2003).
23. Silge, J. & Robinson, D. *Text mining with R: a tidy approach*. (O’Reilly, 2017).
24. World Health Organization. World Health Organization Constitution. *who.int* <https://www.who.int/about/governance/constitution>.
25. Lu, Y. *et al.* Understanding Information Needs and Barriers to Accessing Health Information Across All Stages of Pregnancy: Systematic Review. *JMIR Pediatr. Parent.* **5**, e32235 (2022).
26. Guerra-Reyes, L., Christie, V. M., Prabhakar, A. & Siek, K. A. Mind the Gap: Assessing the Disconnect Between Postpartum Health Information Desired and Health Information Received. *Womens Health Issues* **27**, 167–173 (2017).

27. *Guidelines for perinatal care.* (American Academy of Pediatrics ; The American College of Obstetricians and Gynecologists, 2017).
28. Chames, M. C., Bailey, J. M., Greenberg, G. M., Van Harrison, R. & Schiller, J. H. *Prenatal Care.* (2019).
29. Kelley, A. S., Qin, Y., Marsh, E. E. & Dupree, J. M. Disparities in accessing infertility care in the United States: results from the National Health and Nutrition Examination Survey, 2013–16. *Fertil. Steril.* **112**, 562–568 (2019).
30. Lemoine, M.-E. *et al.* Information needs of people seeking fertility services in Canada: a mixed methods analysis. *Health Psychol. Behav. Med.* **9**, 104–127 (2021).
31. American College of Obstetricians and Gynecologists (ACOG). *Committee Opinion No. 385: The limits of conscientious refusal in reproductive medicine.*
<https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2007/11/the-limits-of-conscientious-refusal-in-reproductive-medicine> (2007).
32. American College of Nurse-Midwives (ACNM). *Position Statement: Access to Comprehensive Sexual and Reproductive Health Care Services.* (2016).
33. Hornberger, L. L. *et al.* Options Counseling for the Pregnant Adolescent Patient. *Pediatrics* **140**, e20172274 (2017).
34. Berglas, N. F., Williams, V., Mark, K. & Roberts, S. C. M. Should prenatal care providers offer pregnancy options counseling? *BMC Pregnancy Childbirth* **18**, 384 (2018).
35. Dugas, C. & Slane, V. H. *Miscarriage.* (StatPearls Publishing, 2022).
36. Merritt Hawkins. *Survey of Physician Appointment Wait Times 2017 and Medicare and Medicaid Acceptance Rates.*
<https://www.merrithawkins.com/uploadedFiles/MerrittHawkins/Content/Pdf/mha2017waittimesurveyPDF.pdf> (2017).
37. Augur, M., Ellis, S. A. & Moon, J. The Early Care Model for Initiation of Perinatal Care: “I Actually Felt Listened To”. *J. Midwifery Womens Health* **67**, 735–739 (2022).
38. Rising, S. Centering Pregnancy An Interdisciplinary Model of Empowerment. *J. Nurse. Midwifery* **43**, 46–54 (1998).
39. Cunningham, S. D., Lewis, J. B., Thomas, J. L., Grilo, S. A. & Ickovics, J. R. Expect With Me: development and evaluation design for an innovative model of group prenatal care to improve perinatal outcomes. *BMC Pregnancy Childbirth* **17**, 147 (2017).
40. Kherwa, P. & Bansal, P. Topic Modeling: A Comprehensive Review. *ICST Trans. Scalable Inf. Syst.* **0**, 159623 (2018).

41. Busse, T. S. *et al.* Approaches to Improvement of Digital Health Literacy (eHL) in the Context of Person-Centered Care. *Int. J. Environ. Res. Public. Health* **19**, 8309 (2022).

42. Di Sotto, S. & Viviani, M. Health Misinformation Detection in the Social Web: An Overview and a Data Science Approach. *Int. J. Environ. Res. Public. Health* **19**, 2173 (2022).

Tables and Figures

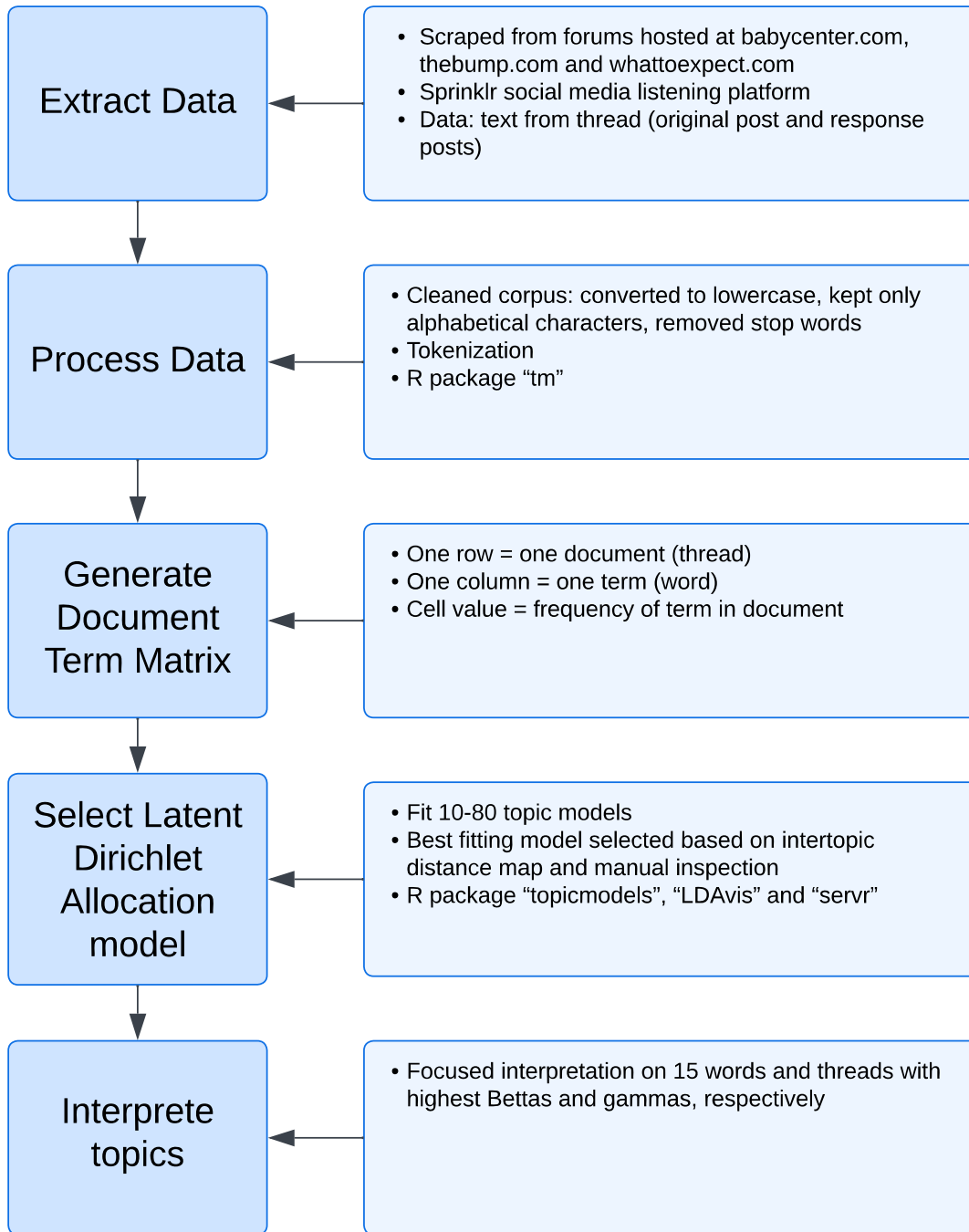


Figure 6.1 Process of analysis

Health related	Category	Topic label	Words	% of tokens
Yes (16 topics)	Fertility	Trying to conceive/monitoring fertility	Cycle, month, day, time, hope, WAYDTGKU, timing, DPO, weekend, testing, length, days, OPKs, LOL, week	5.7%

		Infertility treatments	Cycle, time, transfer, day, IVF, hope, week, testing, feel, clinic, start, IUI, embryos, days, results	4.5%
	Pregnancy ambivalence	Single parenthood or abortion	Baby, feel, time, pregnant, child, husband, life, hard, pregnancy, mom, family, months, hope, anxiety, feelings	3.9%
	Lifestyle	Exercise and health goals	Week, weight, day, yoga, eating, exercise, goals, time, lbs, gain, feel, healthy, days, water, habits	1.3%
	Miscarriage	HCG levels and chemical pregnancy	Period, HCG, days, day, pregnancy, pregnant, loss, ovulation, cycle, weeks, test, progesterone, levels, miscarriage, time	2.9%
		Bleeding and fear of miscarriage	Weeks, ultrasound, bleeding, baby, days, pregnancy, spotting, week, blood, doctor, miscarriage, heartbeat, sac, normal, told	3.4%
	Symptoms	Pregnancy symptoms	Weeks, pregnancy, feel, feeling, symptoms, pain, time, day, pregnant, nausea, morning, night, days, week, normal	3.8%
		Treatment of nausea/vomiting	Doctor, taking, Zofran, meds, day, medication, time, dose, nausea, pills, pregnancy, prescription, pill, prescribed, vomiting	0.9%
	Growth and appointments	Updates on appointments, and fetal growth	Baby, weeks, feeling, days, appointment, questions, due, upcoming, date, second time mom, size, estimated, week, time, feel, foster	3.8%
	Complications	Concern over testing/scan results and weight	Baby, weeks, scan, blood, pregnancy, week, test, ultrasound, doctor appointment, time, weight, results, normal, lbs	3.2%
	Infection	Infections, discharge, and safety of antibiotics	Pregnant, pregnancy, sex, weeks, doctor, baby, discharge, safe, normal, found, birth, infection, call, months, fine	1.1%
	Vaccination	Safety of vaccination	Covid, vaccine, people, pregnant, shot, vaccinated risk, baby, women, vaccines, dose, effects, doctor, pregnancy, research	2.0%
	Planning for delivery	Preparation and support for natural birth	Birth, hospital, midwife, labor, home, natural, baby, doula, time, center, unmedicated, husband, birthing, experience, feel	3.0%
		The labor/delivery experience	Labor, contractions, baby, pain, time, water, epidural, started, weeks, hospital, pushing, body, push, induced, birth	2.6%
		VBAC and prevention of preterm birth	Weeks, baby, section, VBAC, doctor, labor, induction, birth, due, time, pregnancy, induced, cervix, cerclage, hospital	2.0%
	Infant feeding	Infant feeding	Water, milk, drink, baby, day, pump, breastfeeding, drinking, tea, bottle, breast, oil, taking, prenatal, time	1.5%
No (30 topics)	Social exchanges (7 topics)	Birth/pregnancy announcement	Congratulations, congrats, happy, baby, hope, Stella, love, Lane, beautiful, girl, yay, excited, update, glad, Trace	1.1%
		Celebrating pregnancy after infertility/loss	Due, date, weeks, months, time, month, feel, week, excited, pregnancy, baby, appointment, share, June, feeling	2.1%
		Sharing daily life	Time, kids, day, house, week, LOL, home, love, family, husband, night, feel, fun, hope, weekend	3.9%

		Keeping in touch and finding privacy on social media	Post, read, people, insurance, time, appointment, check, posts, book, private, join, start, feel, bump, job	2.0%
		Guessing infant sex	Girl, boy, gender, baby, weeks, ultrasound, boys, Zoe, guess, scan, nub, LOL, girls, Molly, week	1.2%
		Sharing pregnancy test results	Test, line, positive, DPO, days, tests, period, faint, negative, morning, lines, darker, dye, pink, blue	2.5%
		Meal/recipe suggestions	Eat, food, cheese, eating, meal, chicken, love, LOL, time, craving, dinner, cream, chocolate, meat, meals	1.9%
	Product Recommendations (2 topics)	Maternity clothing/packing for hospital	Maternity, clothes, wear, time, baby, LOL, pants, hospital, hair, size, bump, home, cute, nursing, shower	1.5%
		Product recommendations for newborn	Baby, diapers, time, diaper, car, seat, love, months, cloth, nursery, buy, crib, stuff, wash, stroller	2.2%
	Naming baby (21 topics)	Name recommendations	Love, Rose, middle, Elizabeth, Marie, Charlotte, Grace, Claire, Ava, Jane, vote, Elise, Naomi, pretty, Evelyn, Phoenix, Arthur, Aubrey, Cara, Wolf, Clayton, Soren, Isabella, Artie, Maven, Eleanora, Keely, Vanessa, day, Logan, Skye, Jacob, Levi ... Stella, Pearl, Max, Iris, Maeve, names, love, Joel, Hunter, Marigold, dahlia, Amira, Gemma, Perdomo, Eden, Neve, James, Thomas, Eli, Joseph, Jonah, Elias, Phoebe, Wilder, Ari, Brooks, Ezra, love, Carter, Orlando, middle, Girl, boy, names, girls, boys, Harper, Lynn, feminine, unisex, Avery, Rowan, gender, masculine, Riley, love	32.9%
Abbreviations: WAYDTGKU, what are you doing to get knocked up; DPO, days past ovulation; OPKs, ovulation predictor kits; LOL, laugh out loud; IVF in vitro fertilization; IUI, Intrauterine insemination; hCG, human chorionic gonadotropin; lbs, pounds; VBAC, vaginal birth after cesarean				

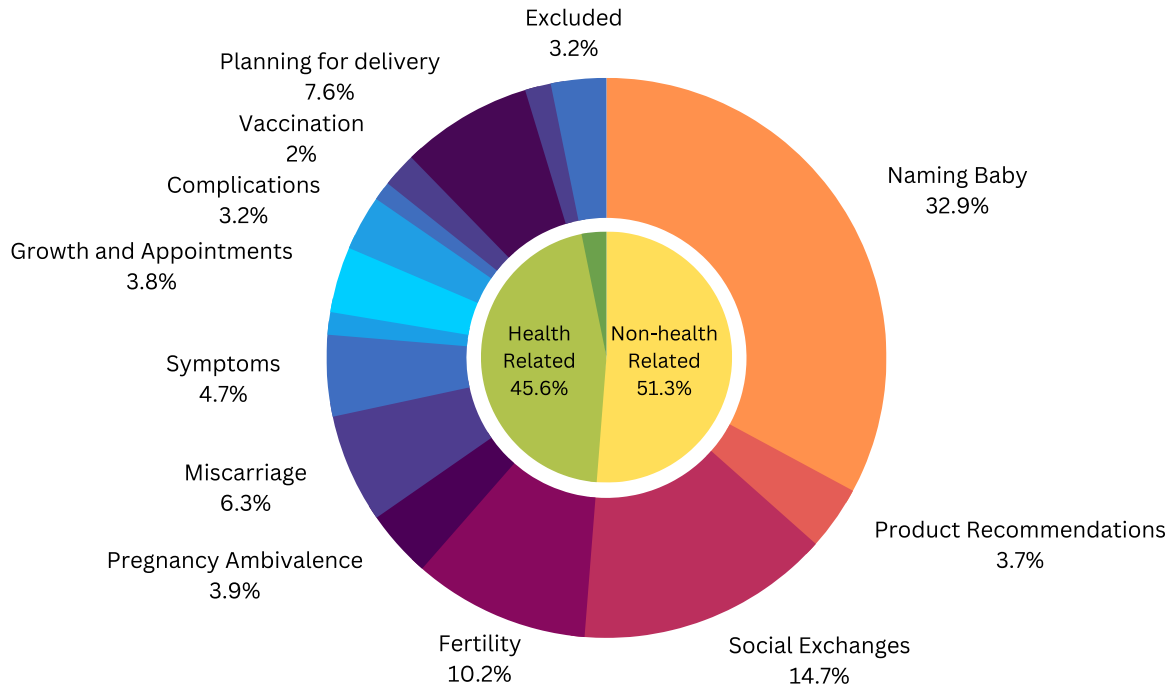


Figure 6.2 Prevalence of health and non-health related topics in online pregnancy forums

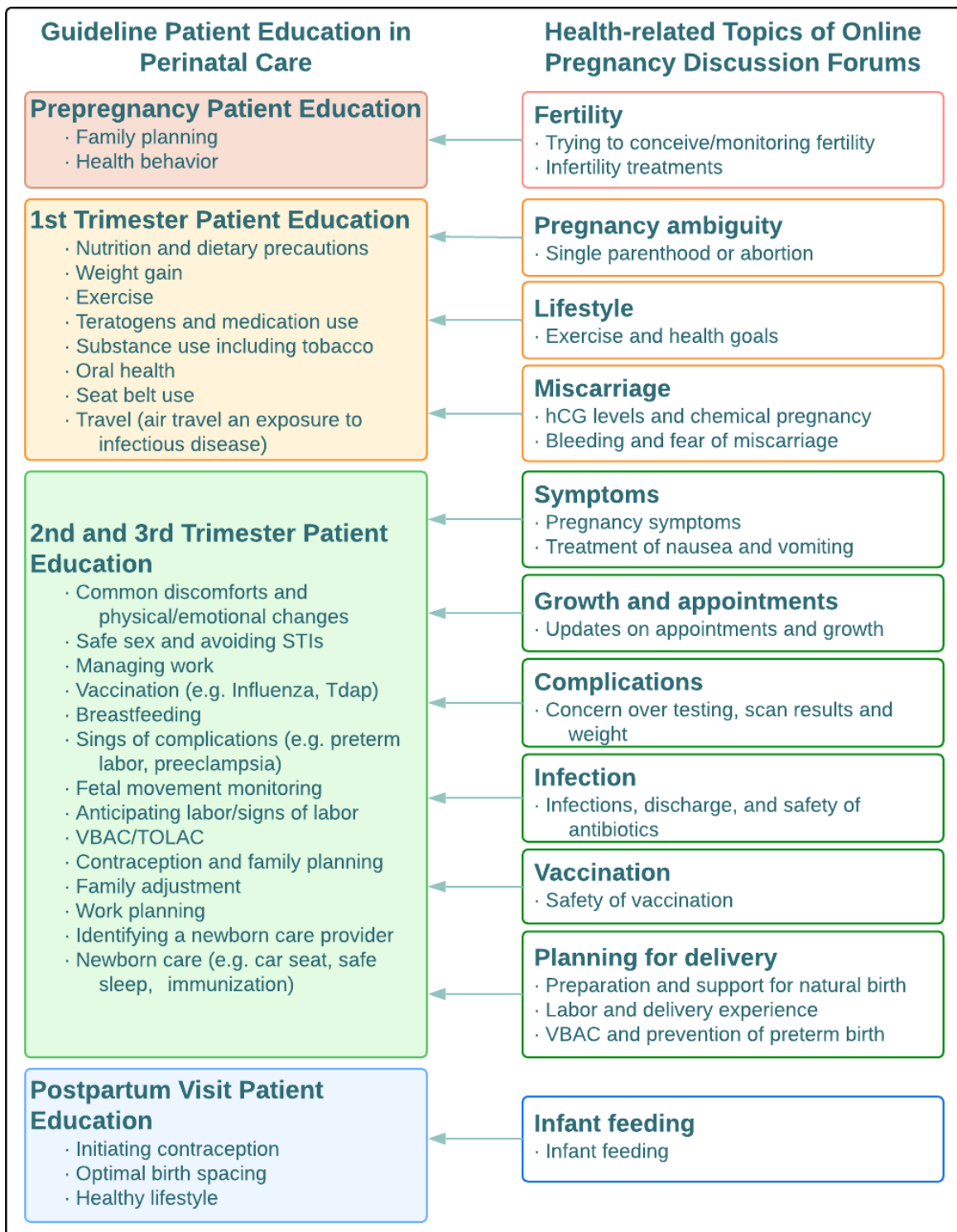


Figure 6.3 Health-related topics and patient education in perinatal care

CHAPTER SEVEN

DISCUSSION

The purpose of this dissertation was to explore factors influencing optimal and equitable perinatal health. Manuscript 1 investigated pregnant persons experience of intersectional discrimination and whether certain discrimination profiles were associated with adverse perinatal health outcomes. Manuscript 2 examined patient characteristics associated with group prenatal care (GPNC) session attendance through quantitative analysis and compared the experience of GPNC patients to individual prenatal care patients (IPNC) through qualitative analysis. Manuscript 3 described the topics discussed by pregnant persons in online discussion forums, highlighting topics related to health.

Summary of Findings

Manuscript One Findings

The first study of my dissertation explored pregnant persons varied and intersecting exposure to discrimination using latent class analysis (LCA) and investigated whether discrimination subgroups differed in risk of adverse perinatal health outcomes (APHOs). This analysis took advantage of data collected in the Centering and Racial Disparities (CRADLE) study, a large randomized controlled trial of pregnant patients at a single obstetrics practice, in which numerous psychosocial and medical outcomes were collected. When conducting latent class analysis, patterns of discrimination were found to differ significantly across race and ethnicity groups and thus were modeled separately. A four-class model was determined to best fit the data for each racial and ethnic group (Black, Hispanic and White). The two largest discrimination classes were similar across racial and ethnic groups, they included participants who reported never to have experienced discrimination labeled the “No discrimination” class and those who

reported experiencing discrimination but did not strongly attribute discrimination to any one social identity labeled the “General discrimination” class. The smaller two classes were more varied across racial and ethnic groups, they included one class of participants who experienced discrimination and had a high probability of attributing discrimination to a single or multiple characteristics (Black: Gender, race, ethnicity and age discrimination; Hispanic: Other discrimination; White: Education, income, weight, appearance and age discrimination) and one class of participants who experienced discrimination and had a high probability of attributing discrimination to most or all characteristics labeled the “compound discrimination” class.

When the association between discrimination subgroups and APHOs were examined using the BCH three step approach, significant between class differences were observed in some cases. Black and White participants that experienced general discrimination were more likely to experience symptoms of postpartum depression relative to participants that did not experience discrimination. Among White participants a significant relationship was also observed for the neonatal outcome of low birth weight. White participants who experienced no discrimination were less likely to give birth to low birthweight infants compared to their peers who experienced general discrimination. That this relationship was present for White, but not Black or Hispanic participants is surprising. Explanations might include high discrimination among White participants based on social identities other than race and ethnicity, as well as differential measure interpretation. An additional unexpected finding was that White participants who experienced compound discrimination were less likely to experience a composite APHO relative to those who experienced general discrimination. This relationship is the opposite than would be expected by theories of intersectionality. Significant difference in adverse perinatal health outcomes between discrimination classes were not observed among Hispanic participants nor for

other APHOs which have previously been identified as associated with discrimination exposure including preterm birth, preeclampsia and NICU admission.

Manuscript Two Findings

The second study of my dissertation applied a concurrent mixed methods design to investigate the association of patient characteristics with GPNC session attendance and to compare patient perceptions of care in GPNC to peers receiving IPNC. A number of patient sociodemographic, psychosocial and health characteristics were found to be associated with session attendance after adjusting for eligibility to attend sessions (i.e. based on study enrollment and date of delivery). Sociodemographic characteristics of older age, birth outside the United States, being married and having higher educational attainment and income were positively associated with session attendance. While psychosocial characteristics of below average prenatal distress, housing instability, housing concerns, and life stressors in pregnancy were inversely associated with session attendance. Health characteristics of gestational diabetes and smoking during pregnancy were also inversely associated with session attendance. Additionally, younger age and below average perceived stress were positively associated with non-attendance.

Qualitative analysis uncovered five themes in the patient experience including 1) monitoring of fetal wellbeing, 2) the patient-provider relationship, 3) engagement and education, 4) trust in and support from peers and 5) involvement of support persons. A number of themes were largely consistent between IPNC and GPNC patients including the primacy of fetal wellbeing and the desire for a familiar and friendly provider. GPNC was seen to offer alternative opportunities for education and engagement and peer support. Yet, unique concerns also arose for GPNC patients including the comfort of their partner and provider confidentiality in the transition from one-on-one conversations to the group discussion. The match between patient

characteristics and care elements can aid in understanding attendance patterns. These patterns might also be linked to barriers associated with these patient characteristics.

Manuscript Three Findings

The third dissertation study sought to utilize Latent Dirichlet Allocation (LDA) topic modeling to describe the topics discussed by pregnant persons in online peer communities, with particular emphasis on health-related topics. User generated content was scraped from three active online pregnancy groups over a one-year period. Topic interpretability for models with 10-80 topics were compared and the fifty-topic model selected to best fit the data. Four of the fifty topics were not found to represent semantically coherent topics. These 16 health related topics composed 46% of discussion threads. The most common health related topic categories were fertility, planning for delivery, miscarriage and pregnancy symptoms. Other health related topic categories included pregnancy ambivalence, growth and appointments, complications, infection, vaccination, and infant feeding. Non health related topics composed 51% of discussion threads and included categories of topics such as baby name and product recommendation, as well as social exchanges.

Strengths and Limitations

Several strengths were demonstrated in this dissertation. Some strengths were shared by study one and two as they both involved secondary analysis of data collected in the CRADLE study. Included within this dataset is a relatively large sample of racially and ethnically diverse largely low-income pregnant patients. The practice at which the CRADLE study took place had been conducting GPNC for over ten years. Data collection in the CRADLE trial was rigorous, a broad range of sociodemographic and psychosocial variables were collected using validated self-report measures and health variables collected through medical chart abstraction.

In addition to the strengths inherent to this dataset, study one applied an innovative statistical approach, LCA to the study of discrimination exposure in pregnancy. Rather than measuring a single dimension of discrimination as has largely been done in previous research, this study was guided by an intersectionality perspective. An intersectionality perspective recognizes that the human experience is jointly shaped by multiple social identities and cannot be adequately understood when considered in isolation.¹ Unlike variable centered approaches, LCA takes a person-centered approach allowing for the examination of complex co-occurring experiences. Study two also had methodological strengths, through the application of a concurrent mixed methods study design incorporating both quantitative and qualitative analysis, this design synthesizes the individual strengths of each method.² Study two also included a qualitative comparison group (IPNC patients) which allowed for conclusions to be made about the similarities and differences of patient experience in each care model to be made.³

Although different, the sampling method of study three also offered several benefits. Through analysis of user generated content in online pregnancy forums we take advantage of the abundant wealth of naturally occurring data in this community space. In contrast to traditional research methods such as survey and interview this data is unprompted thus removing bias introduced through interaction with the researcher or research tools. Study of user generated content may allow for the inclusion of populations who would be unlikely to participate in traditional research and social desirability bias may be lessened in relatively anonymous online spaces contributing to greater openness in the discussion of sensitive topics. Use of text mining methods also offers benefits. Utilization of LDA topic modeling enabled us to summarize the themes present in this large unstructured text dataset relatively quickly. Analysis of such a large data set would not be feasible through qualitative analysis.

This dissertation is not however without limitations. While the CRADLE sample has several strengths, participants were recruited from a single medical practice largely catering to a medically underserved population, the findings of study one and two may not therefore be generalizable to other populations. In accordance original trial aims and eligibility criteria for participation in GPNC, medically high-risk pregnancies were excluded from participation. A focus on medically low risk pregnancies may have attenuated findings regarding the association of discrimination with APHOs, particularly among Black pregnant persons who might be expected to have worsened health at entry to prenatal care due to the accumulation of disadvantages across the life course. Although the CRADLE study provided a relatively large sample for analysis, subdivision of participants into race and ethically stratified groups followed by discrimination classes may have limited our power to detect difference and replication of findings in a larger sample is recommended.

For study one, our measure of discrimination may also represent a limitation. Despite the Everyday Discrimination Scale (EDS) being one of the most commonly used measure of discrimination and a number of studies documenting the instrument's good reliability and validity,⁴ several recent studies have cast doubt the EDS's equivalence across diverse social groups.^{5,6,7} Establishing measurement equivalence across diverse social groups is essential for accurate and meaningful comparison. These studies therefore suggest caution is needed when using the EDS to make cross group comparisons.

In study three, sociodemographic information was not available on the users posting in online forums, we are therefore unable to make claims about the generalizability of findings. While topic modeling has been found to produce semantically coherent and interpretable topics, topics identified do not indicate all the topics discussed in online forums but rather word clusters

determined to have strong co-occurrence.⁸ Topic modeling does replace the contextual understanding of manual qualitative analysis.⁹ Finally, the field of topic modeling is an emerging area of research and there are not specific recommendations for best practice in particular settings. LDA involves a number of decisions be made that can influence the outcomes of analysis. For instance, a variety of different quantitative and qualitative approaches have been recommended for the selection of the number of topics.¹⁰

Implications and Future Directions

Study findings offer important implications for clinical care, as well as revealing several potential areas for future research.

Intersectional Discrimination

By incorporating an intersectionality perspective, our study builds upon previous research documenting the association of single axis discrimination with perinatal health. Dissertation findings highlight the importance that pregnant person's discrimination exposure be assessed using an intersectionality framework, that attends to how multiple social identities and interlocking systems of power and oppression intersect to shape an individual's experience.

While replication of findings within a larger sample is needed, findings of association of elevated risk suggest the utility of assessing intersectional discrimination exposure in prenatal care.

However, this endeavor may be complicated by methodical issues in the measurement of intersectional discrimination. Though requiring further examination these findings may suggest alterations or development of alternative measures are needed. A new instrument the

Intersectional Discrimination Index (InDI) a measure specifically developed to assess

discrimination across intersections was recently introduced and has shown good preliminary

validity and reliability.¹¹ Future studies of intersectional discrimination should consider the merits of utilizing this new instrument.

Participation in Group Prenatal Care

Dissertation findings suggest GPNC session attendance differs based on patient sociodemographic, psychosocial and health characteristics. Characteristics inversely associated with sessions attendance were largely consistent with socially disadvantaged statuses (e.g. lower education, lower income, housing instability). These findings are distinct from measurement of adequacy of care. Participants were able to switch over to IPNC visits or to attend IPNC visits as desired. However, patient characteristics associated with GPNC attendance may not be unique to this this model of care, and some characteristics identified appear consistent with prenatal care more generally, while others appear to be unique to the GPNC model. Future research should investigate how and if patient characteristics associated with GPNC attendance differ from those associated with IPNC attendance, as well as replicating study findings in diverse samples. Differences might suggest a fit between care models and certain populations. Dissertation findings offer insights for patient recruitment and retention as well as potential model modifications. Modifications and adaptations to the GPNC model that could further facilitate session attendance among patient populations with poor attendance should be considered. These findings add to literature informing the shared decision-making process between patients and providers in selecting the appropriate model of prenatal care. A decision aid might be created, conveying evidence-based information on the benefits and drawbacks of GPNC as well as other care options. Presently a variety of pregnancy related decision aids exist for decisions such as mode of birth and prenatal testing,¹² but a decision aid for model of prenatal care is not known to exist.

Quality Prenatal Care and Disparities in Perinatal Health

While not sufficient on its own, access to quality prenatal care is an important component of strategies to reduce Black-White disparities in perinatal health.¹³ GPNC is one promising intervention to reduce Black White disparities in birth outcomes. The benefits of GPNC can only be obtained to the extent GPNC is attended. Although analysis did not uncover significant differences in GPNC session attendance by race and ethnicity, patient characteristics largely consistent with social disadvantage were associated with reduced attendance. Modifications may be needed to the GPNC model to support these populations in obtaining the benefits of GPNC. It is not known how patient characteristics associated with session attendance compare to those associated with IPNC or adequacy of care more generally. Differences in model elements (e.g. visit/session length) create challenges in directly comparing “dose” of intervention received. Measures of adequacy of care have largely relied on timing of care initiation and the total number of visits received. The developments of instruments to assess patient perceptions of care quality including components of care (e.g. provider-patient communication, patient autonomy and respect and information sharing) can also assist in clarifying what models of care best fit patient needs.

Seeking Health Information Online

Dissertation findings emphasize the role online forums play in the exchange of health information during pregnancy. In addition to ease and convenience, previous studies suggest pregnant persons turn online to fulfill information needs not meet offline.¹⁴ Common topics identified in online forums may represent information gaps offline and consideration should be given to opportunities to enhance patient education in these areas. Review of guidelines for patient education in perinatal care suggest some topics such as fertility, miscarriage and

pregnancy ambivalence are not included within standard patient education. These topics as well as other prominent topics discussed in online forums can alert providers and health organizations to areas of unmet informational need, informing efforts to enhance patient education. While the internet provides increased access to information there is concern about the accuracy of information found online. Health care providers should engage their patients in discussions about the health information found online encouraging digital literacy skills.

Text mining methods are tools that enable researchers to organize and summarize large volumes of unstructured data, such as that in online forums. The importance of text mining methods will continue to grow within this “big data” era. Text mining methods such as topic modeling can also be employed in conjunction with qualitative methods. In a mixed methods approach, text mining techniques can provide a sampling frame from which content of interest can be qualitatively analyzed.¹⁵ In addition to further clarification of themes discussed in online pregnancy forums, large scale assessment of health information quality is also needed. Future research should investigate the accuracy of health information shared among peers.

“Big data” being produced by electronic medical record systems including electronic patient portals also presents an opportunity to apply text mining methods. For instance, similar topic modeling could be performed on the unstructured text data produced through in patient and provider conversations within patient portals. Through examination of topics discussed in patient portals additional insight could be gained into unmet informational needs causing patients to reach out between visits. This analysis would have the advantage of known sample and practice demographics. These findings would have direct applications to the practice, as well as could be compared to those topics we see in online forums. This comparison could enhance our

understanding of what topics patients seek information from providers versus those sought primarily within peer forums.

Perinatal Education in a Group

Perinatal information needs identified in online pregnancy forums may be better addressed in GPNC, through facilitated group discussion and additional time spent with one's health care provider. Patient interviews identified GPNC as offering alternative opportunities for education and engagement, consistent with previous research.¹⁶ Similar to online pregnancy forums, GPNC provides pregnant persons opportunities to listen and share with peers. This interaction may better meet pregnant persons desire for experiential knowledge from their peers. Some GPNC models have incorporated IT platforms which allow patients to connect with group members and providers through the online portal between group visits.¹⁷ This component may could meet patients desire for convivence and accessibility. Delivery of GPNC virtually is also being piloted.¹⁸ Lack of transportation and childcare and time constraints have commonly been raised as reasons for low GPNC attendance,¹⁹ and may have contributed to differential patterns of attendance observed among certain patient groups. Telehealth has the potential to reduce certain barriers to access to care such as transportation, travel time and childcare.²⁰ Implementation of virtual care was accelerated in response to the COVID-19 pandemic, thus research examining the acceptability and tradeoff of these modalities has grown. Research should continue to explore technologies application to enhancing the access and quality of prenatal care both directly in practice and indirectly as a means better understanding patient needs through research.

Disparities in Accessing Health information Online

When we consider how digital health information may relate to perinatal health disparities, there are both reasons to believe access to digital health information will decrease health disparities

through the enhancement of shared decision making and informed choice and that existing health inequalities may be reinforced or exacerbated by unequal access.^{21,22} The PEW Research Center estimates that 93% of adults presently use the internet. Yet despite high use, adoption gaps based on factors such as age, income and education remain.²³ A recent examination of virtual prenatal care suggests patients with low educational attainment were less likely to use virtual prenatal care and experienced significant barriers to virtual care including access to technology and a private space for the visit.²⁴ As growing attention is given to the implementation of virtual care as an alternative to in person prenatal care visits, disparities in access and skill must be considered.

References

1. Bowleg, L. The Problem With the Phrase *Women and Minorities*: Intersectionality—an Important Theoretical Framework for Public Health. *Am. J. Public Health* **102**, 1267–1273 (2012).
2. Creswell, J. W. & Plano Clark, V. L. *Designing and conducting mixed methods research*. (SAGE, 2018).
3. Lindsay, S. Five Approaches to Qualitative Comparison Groups in Health Research: A Scoping Review. *Qual. Health Res.* **29**, 455–468 (2019).
4. Bastos, J. L., Celeste, R. K., Faerstein, E. & Barros, A. J. D. Racial discrimination and health: a systematic review of scales with a focus on their psychometric properties. *Soc. Sci. Med.* **1982** **70**, 1091–1099 (2010).
5. Harnois, C. E., Bastos, J. L., Campbell, M. E. & Keith, V. M. Measuring perceived mistreatment across diverse social groups: An evaluation of the Everyday Discrimination Scale. *Soc. Sci. Med.* **232**, 298–306 (2019).
6. Bastos, J. L. & Harnois, C. E. Does the Everyday Discrimination Scale generate meaningful cross-group estimates? A psychometric evaluation. *Soc. Sci. Med.* **265**, 113321 (2020).
7. Harnois, C. E. What do we measure when we measure perceptions of everyday discrimination? *Soc. Sci. Med.* **292**, 114609 (2022).
8. Blei, D. M., Ng, A. Y. & Jordan, M. I. Latent Dirichlet Allocation. *J. Mach. Learn. Res.* **3** 993–1022 (2003).
9. Chang, J., Gerrish, S., Wang, C., Boyd-Graber, J. & Blei, D. Reading tea leaves: How humans interpret topic models. *Adv. Neural Inf. Process. Syst.* (2009).
10. Hagg, L. J. *et al.* Examining Analytic Practices in Latent Dirichlet Allocation Within Psychological Science: Scoping Review. *J. Med. Internet Res.* **24**, e33166 (2022).
11. Scheim, A. I. & Bauer, G. R. The Intersectional Discrimination Index: Development and validation of measures of self-reported enacted and anticipated discrimination for intercategory analysis. *Soc. Sci. Med.* **226**, 225–235 (2019).
12. Kennedy, K. *et al.* Shared decision aids in pregnancy care: A scoping review. *Midwifery* **81**, 102589 (2020).
13. Lu, M. C. *et al.* Closing the Black-White gap in birth outcomes: a life-course approach. *Ethn. Dis.* **20**, S2-62–76 (2010).

14. Lagan, B. M., Sinclair, M. & George Kernohan, W. Internet Use in Pregnancy Informs Women's Decision Making: A Web-Based Survey. *Birth* **37**, 106–115 (2010).
15. Andreotta, M. *et al.* Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behav. Res. Methods* **51**, 1766–1781 (2019).
16. Heberlein, E. C. *et al.* Qualitative Comparison of Women's Perspectives on the Functions and Benefits of Group and Individual Prenatal Care. *J. Midwifery Womens Health* **61**, 224–234 (2016).
17. Cunningham, S. D., Lewis, J. B., Thomas, J. L., Grilo, S. A. & Ickovics, J. R. Expect With Me: development and evaluation design for an innovative model of group prenatal care to improve perinatal outcomes. *BMC Pregnancy Childbirth* **17**, 147 (2017).
18. Dai, J. *et al.* The Experience of Pregnant Women in the Health Management Model of Internet-Based Centering Pregnancy: A Qualitative Study. *Int. J. Womens Health* **Volume 14**, 1281–1289 (2022).
19. Francis, B., Klebanoff, M. & Oza-Frank, R. Racial discrimination and perinatal sleep quality. *Sleep Health* **3**, 300–305 (2017).
20. Ghimire, S., Martinez, S., Hartvigsen, G. & Gerdes, M. Virtual prenatal care: A systematic review of pregnant women's and healthcare professionals' experiences, needs, and preferences for quality care. *Int. J. Med. Inf.* **170**, 104964 (2023).
21. Gann, B. & Grant, M. J. From NHS Choices to the integrated customer service platform. *Health Inf. Libr. J.* **30**, 1–3 (2013).
22. McAuley, A. Digital health interventions: widening access or widening inequalities? *Public Health* **128**, 1118–1120 (2014).
23. Pew Research Center. Internet/Broadband Fact Sheet. *Pew Research Center* <https://www.pewresearch.org/internet/fact-sheet/internet-broadband/> (2021).
24. Lee, J. & Manalew, W. S. Reasons for Not Pursuing Virtual Prenatal Care in 2020 Through 2021 and Policy Implications. *Telemed. E-Health* tmj.2022.0492 (2023) doi:10.1089/tmj.2022.0492.