



Moving towards Justice: Reducing Encounters of Preeclampsia in Adolescent Maternal Health

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Abstract

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Keywords

preeclampsia; adolescent pregnancy; health justice; health disparities; income



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ABSTRACT

Using data from the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be (nuMoM2b), several relationships were explored between nutrition and diet, likely attributed to education, culture, training, and habits around food. While these factors remain relevant and worth pursuing, data analysis implied that the most significant issue remaining is access to healthcare. Across race, age, and nutrition consumption, if pregnant people make higher incomes—inferring better access to healthcare and higher-quality nutrients, then their risk of preeclampsia is reduced. Accordingly, this paper performs an extensive literature review of the intersection of extreme maternal age and nutrient intake as a significant factor for preeclampsia. Given the current gap in literature around adolescent pregnancy and preeclampsia, special focus is given to birthing people between 10 and 19 years of age. Quantitative machine learning analysis of the nuMoM2b dataset and qualitative analysis of ethnographic findings from the NMHRN October 2020 conference are used to inform policy proposals that benefit adolescent birthing people, birthing people experiencing preeclampsia, and birthing people negatively impacted by the current healthcare system.

Keywords: preeclampsia, adolescent pregnancy, health justice, health disparities, income

INTRODUCTION

Adolescence, the developmental stage following childhood and defined between the ages of 10 and 19 according to the World Health Organization (WHO), is a critical stage for human beings (WHO, 2020). Alongside physical growth, individuals grow cognitively and psychosocially as their bodies and minds contribute to the foundation of their adult selves and adult health. Yet, one of several challenges to healthy adolescent development is adolescent pregnancy. Annually,

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approximately 21 million birthing people ages 10 to 19 become pregnant. Of this number, approximately 13 million give birth (Darroch et. al., 2015). Among developed nations, the United States has one of the higher rates of adolescent pregnancy compared to its peers with 3 out of 10 Americans becoming pregnant by age 20 (CDC, 2012; Rounds et. al., 2014).

Challenging physical and psychosocial development, adolescent pregnancy contributes to lower academic achievement, increased health care costs, and heightened risk of living in poverty (Kingston et. al, 2012). Adolescents also experience adverse pregnancy and birthing outcomes that significantly impact the development of neonates, infants, and the birthing person across all countries (Rosales-Ortiz et. al., 2015). This paper focuses on preeclampsia as an adverse health outcome for pregnant and birthing adolescents.

Preeclampsia, “a multisystem disorder characterized by new onset hypertension and proteinuria in pregnant [people] beyond 20 weeks’ gestation”, and its more severe forms of eclampsia and HELPP syndrome (Hemolysis, Elevated Liver enzymes and Low Platelets) are more frequent in young, first-time pregnant people from low socioeconomic status than other adverse outcomes (Carty et. al., 2008; Rosales-Ortiz et. al., 2015). The syndrome accounts for approximately 10-15% of maternal deaths globally (Xu et. al., 2009).

Despite inconsistencies with cohort sizes and methodological limitations, traditional studies report that the prevalence of preeclampsia among adolescent birthing people is upwards of 20% higher than adult pregnant people (Rosales-Ortiz et. al., 2015) and most prevalent at the extremes of maternal age—younger than 18 and older than 35 (Carson, 2018). Among this demographic, preeclampsia increases risk of “adverse maternal (i.e., severe complications, morbidity, maternal near-miss cases and cesarean deliveries) and perinatal outcomes (i.e., preterm birth, intrauterine growth restriction [IUGR], low birth weight and admissions to intensive care units)” (Parra-Pingel et. al., 2017).

Much research concludes younger adolescents (≤ 15.9) experience greater risks of preeclampsia than older adolescents (16–19.9) (Kawakita et. al., 2016). Contending with preeclampsia, gynecological immaturity and competition for nutrients between the birthing person and the fetus have been associated with restricted fetal growth and increased risk of low birth weight in this age group (15-19) (Lee et. al., 1998). Yet, studies investigating the relationship between adolescent pregnancy and nutrient intake appear to be limited and out of date.

While adolescence is not a determining factor for preeclampsia, nutrient intake and socioeconomic status appear to have direct bearing on preeclampsia in adolescents. Essential vitamins and minerals, or micro- and macronutrients, “are dietary components required in small quantities to support virtually all metabolic activity...that regulate tissue growth, function and homeostasis” (Gernand et. al., 2016). These nutrients support the fetus’ development over the course of pregnancy and their suggested intake partially varies by the birthing person’s nutritional status prior to pregnancy and geographical location (e.g., developed nation, nation experiencing conflict, nation experiencing ongoing natural disasters) (Gernand et. al., 2016).

Research findings link adolescents whose diets lack appropriate amounts of calcium, magnesium, iron, zinc, vitamins C and E, and essential fatty acids with higher preeclampsia outcomes. Deficiencies in these micronutrients can result from poor diet or malnutrition entering pregnancy (Aliyu et. al., 2010). There are critical challenges diet poses to developing adolescents, their fetuses, and risk of preeclampsia; therefore, this article describes the authors’ process of using data from nulliparous birthing people to uncover additional links between diet, adolescence, and

preeclampsia. These authors describe methods used to parse through the data and find linkages, then report results of disparities in this sample size.

METHODS

The study was conceptualized as a contribution to the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Decoding Maternal Morbidity Data Challenge. Following the goal of the challenge to deliver a new solution to improve maternal health through computational analysis and data mining, the authors analyzed the dataset from the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-be (nuMom2b) to identify links between adolescent pregnant people, diet, and preeclampsia.

nuMoM2b Study Background

The data garnered from the original observational study beginning September 2010 included 10,037 participants in a cohort-style model gathering data across 11,617 coded, characterized, or numerized variables related to pregnancy and birthing experiences. Participants were required to be 13 years or older and identify as nulliparous pregnant women. Racial, ethnic, age, and geographically diverse women were enrolled across eight clinical sites across the United States—Case Western Reserve University; Columbia University; Indiana University; Northwestern University; Magee-Women’s Hospital; RTI International; University of California, Irvine; University of Pennsylvania; and University of Utah (NICHD, 2021):

Nulliparous women in the first trimester of pregnancy were recruited into an observational cohort study. Participants were seen at 3 study visits during pregnancy and again at delivery. We collected data from in-clinic interviews, take-home surveys, clinical measurements, ultrasound studies, and chart abstractions. Maternal biospecimens (serum, plasma, urine, cervicovaginal fluid) at antepartum study visits and delivery specimens (placenta, umbilical cord, cord blood) were collected, processed, and stored. The primary outcome of the study was defined as pregnancy ending at <37+0 weeks’ gestation. (Haas et al., 2015)

While standard obstetric care was provided at each medical site, 3 study visits occurring per trimester—which were not a part of clinical, maternal care—were performed by nuMoM2b-affiliated researchers. The first study visit occurred between 6- and 13-weeks’ gestation to measure “blood pressure, height, weight, and waist, hip, and neck circumference” (Hass et al, 2015). Participants engaged in interviews, sharing demographic data, medical history, and lab specimens; medicinal, substance, and food intake; perceived mental health and reactions to social justice concerns; and parental relations (Hass et al, 2015).

Participants’ second visit took place at least one month after the first visit, between 16-and-21 weeks’ gestation. Clinical measurements, substance and food intake, labs, and demographic data were collected again alongside interviews to gauge personal health literacy and reactions to social justice issues. “Sonographic assessment of fetal biometry, cervical length, and uterine artery Doppler measurements” were also performed at this visit (Hass et al, 2015). The final study visit occurred at least one month after the second between 22-and-29 weeks’ gestation. The aforementioned data collection was repeated for a final time accompanied by “a survey of sleep patterns and habits, pregnancy experience, and difficulties in pregnancy” (Hass et al, 2015). Within an hour of delivery, specimens (e.g., placenta, membranes, umbilical cord, and blood) were collected and approximately 30 days after delivery medical records were reviewed for final birth outcomes. The initial study recruitment ran for 3 years and enrolled 10,037 birthing people, of whom the mean age was 27 and gestational age at initial screening was 12 weeks. Of the

participants, 59.7% were non-Hispanic white, 14.2% were non-Hispanic black, 16.9% were Hispanic, 4% were Asian, and 5.1% self-classified as other (Hass et al, 2015). Figures 1 and 2 provide an overview of data documentation categories per the corresponding study visits (Data Coordinating and Analysis Center at RTI International, 2019).

Figure 1. nuMoM2b Public Database Documentation: Question Domains and Clinical Evaluations by Study Visit

nuMoM2b Public Database Documentation

Table 4-1. Question Domains and Clinical Evaluations by Study Visit

Question Domains, Samples, and Clinical Evaluations	Study Visit*			Delivery
	1	2	3	
Demographic characteristics				
Demographics of Mother/Changes	X	X	X	X
Background of Mother's Parents	X	X		
Demographics of Father and Background of Father's Parents (if appropriate)		X		
Standard instruments (see Table 4-2 for details)	X	X	X	
Medical history				
Mother	X	X	X	X
Mother's Family	X	X	X	
Medications and Supplements	X	X	X	X
Substance use- Alcohol, Tobacco, Drugs	X	X	X	X
Other Psychological Factors				
Reactions to Race	X			
Pregnancy Intendedness	X			
Difficulties in Pregnancy	X		X	
Relationship with Father of Baby	X	X	X	
Signs/Symptoms Preceding Delivery Hospitalization				X
Participant Assessment of Route and Reasons for Delivery				X
Blood Pressure** and Weight	X	X	X	
Height; Waist, Hip, and Neck Circumference	X			
Ultrasound for Crown-rump Length	X			
Ultrasound for Fetal Biometry		X	X	
Ultrasound for Cervical Length		X	X	
Ultrasound for Uterine Artery Doppler Measurement	X***	X	X	

* Study visits 1, 2, and 3 were during the following gestational age intervals, respectively: 6 week 0 days to 13 weeks 6 days; 16 weeks 0 days to 21 weeks 6 days; and 22 weeks 0 days to 29 weeks 6 days.

** If a blood pressure reading >140/90 was obtained, the participant was to rest for 10 minutes and have it repeated in the standard way. The second blood pressure was then reported. No notification was required if the second value was elevated as all participants were receiving routine prenatal care in which blood pressure was recorded.

*** Optional.

Figure 2. nuMoM2b Public Database Documentation: Standard Instruments by Domain and Study Visit when Administered

nuMoM2b Public Database Documentation

Table 4-2. Standard Instruments by Domain and Study Visit When Administered

Domain	Standard Instrument*	Study Visit**		
		1	2	3
Health Literacy	Rapid Estimate of Adult Literacy in Medicine Short Form (REALM-SF)		X	
Nutrition	Modified Block 2005 Food Frequency Questionnaire	X		
Physical Activity	Recent Physical Activity Log	X	X	X
Psychosocial	Experiences of Discrimination (EOD)		X	
	Multidimensional Scale of Perceived Social Support (MSPSS)	X		
	Pregnancy Experience Scale, Brief Version (PES-Brief)			X
	Connor-Davidson Resilience Scale (CD-RISC)		X	
Sleep	Women's Health Initiative Insomnia Rating Scale	X		X
	Epworth Sleepiness Scale	X		X
	Restless Legs Syndrome Diagnostic Criteria	X		X
	Berlin Questionnaire for Sleep Apnea	X		X
Stress/Mental Health	State-Trait Anxiety Inventory - Trait Subscale (STAI-T)	X		
	Edinburgh Postnatal Depression Scale (EPDS)	X		X
	Perceived Stress Scale (PSS-10)	X		X
Other	Pregnancy-Unique Quantification of Emesis and Nausea (PUQE)	X	X	X

* References for the standard instruments appear as footnotes on the data collection instruments in *Tab 05* of this documentation.

** Study visits 1, 2, and 3 were during the following gestational age intervals, respectively: 6 week 0 days to 13 weeks 6 days; 16 weeks 0 days to 21 weeks 6 days; and 22 weeks 0 days to 29 weeks 6 days.

nuMoM2b-Informed NICHD Data Challenge

Once approved and granted access to the nuMoM2b dataset and deidentified code book by NICHD, the authors performed focus group coding in RStudio and began seeking connections between adolescent pregnancies—ages 13-20 years given the youngest age allowed for the study was 13 and 20 is the maximum age in adolescent birthing statistics in the U.S.—and calcium and magnesium intake as these two macronutrients are linked to preeclampsia outcomes.

First a boolean variable was created that was true for any participant that experienced eclampsia or preeclampsia preterm or as a delivery reason. Using analysis of variance (ANOVA), the authors confirmed that an age split of ≤ 20 and > 20 had a significant difference in mean for this outcome variable. The authors cross-referenced the nutrition code book to determine which nutrition variables surveyed in the original dataset contained high levels of calcium and/or magnesium (e.g., leafy greens, white fish, cereal, dietary supplements, cottage cheese, cold cereal), which could significantly predict this eclampsia outcome using linear regression.

Of the nutrition variables which significantly predicted the eclampsia outcome (COLDCEREALQUAN), some were no longer significantly predictive after accounting for the age category (≤ 20), determined with analysis of covariance (ANCOVA). The authors then ran several ANOVA's between race/ethnicity and each significant nutrition variable among study participants twenty and younger. Finally, household income was introduced and several ANOVA's and ANCOVA's were run among the adolescent population involving race, ethnicity, household income, and the eclampsia outcome. Figure 3 provides an overview of the food frequency survey pertaining to a healthy nutrient intake per the 2005 Block Food Frequency Questionnaire (Data Coordinating and Analysis Center at RTI International, 2019).

Figure 3. Dataset Information Regarding Food_Frequency_Analysis of nuMoM2b Study

Dataset Information for the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-be (nuMoM2b)										
Prepared July 2020										
No.	Dataset Name	Dataset Title	Keywords	Total # of Columns	Total # of Rows	Corresponding Case Report Form (CRF) Name	CRF Study Timepoint	CRF Section Heading Names	Relevance to Maternal Morbidity (Y/N)	Comments
38	food_frequency_analysis	nuMoM2b Food Frequency Questionnaire Data and Nutrient Analysis [Food Frequency Analysis] Dataset	Food intake; Food types; Vitamins; Nutrients	734	7,679	Modified Block 2005 Food Frequency Questionnaire (FFQ) (http://www.nutritionquest.com)	Ancillary	5.13.1 Food_Frequency_Analysis: Food Frequency Questionnaire Data and Nutrient Analysis See documentation: nuMoM2b-Database-Documentation-Public-Version 01-20190304-Final.pdf	Y	Dietary intake for the three calendar months before becoming pregnant was assessed at visit 1 using the self-administered FFQ questionnaire

RESULTS

Based on the performed analyses of the dataset, the authors began by looking at the impact of diet and nutrition on eclampsia and preeclampsia outcomes within adolescent and non-adolescent pregnancies. For the first analysis, they tested if there was a difference between the age of the populations experiencing any kind of preeclampsia compared to those who did not (Figures 4 and 5). Of those surveyed, 449 people experienced some form of preeclampsia while 8,350 did not, these data excluding participants who withdrew from the study following the start of participant observation for varying reasons. The most notable difference across these two groups was the absence of eclampsia cases for pregnant people ages 13 and 14; however, it is worth noting there was a spike in eclampsia reporting for older adolescents ages 18 and 19.

Figure 4. Percentage of Eclampsia across Age

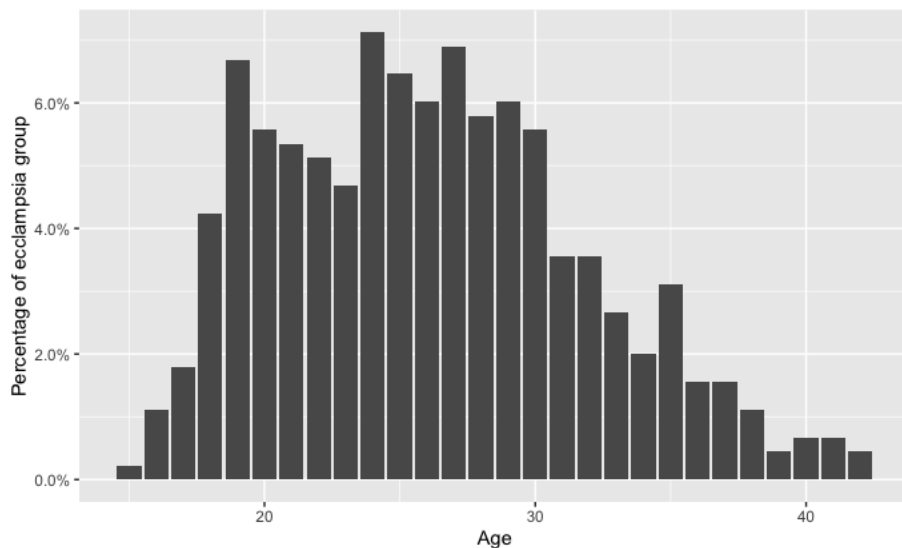
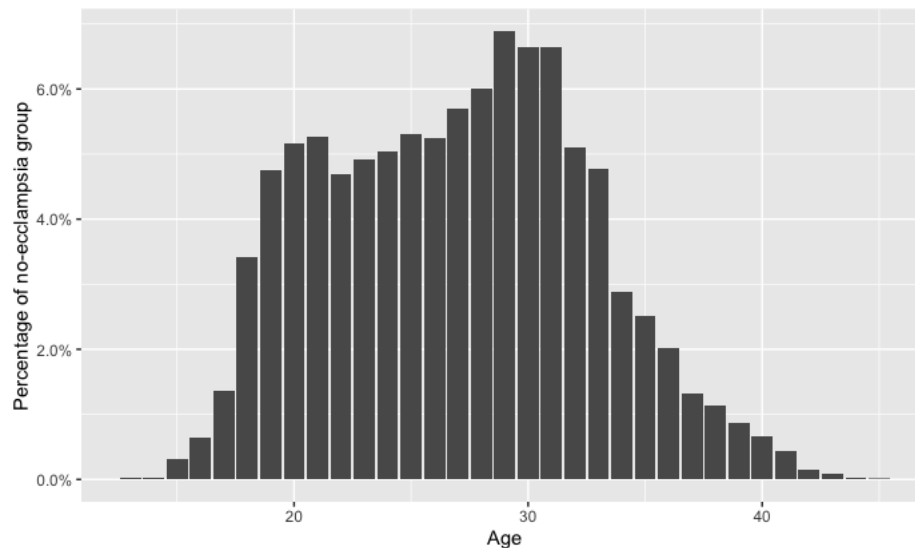


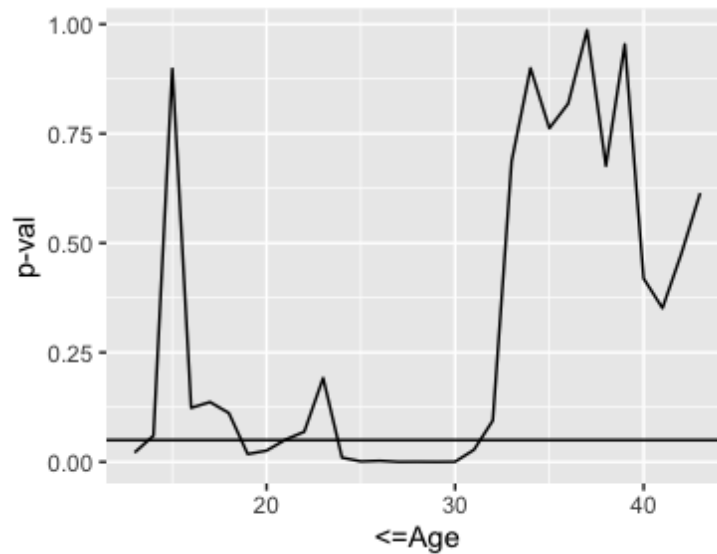
Figure 5. Percentage of No Eclampsia across Age



A one-way ANOVA test was then performed to determine if there was a statistically significant difference between the preeclampsia and no-preeclampsia distributions, of which there was ($p < 0.01$). Alongside this ANOVA, pairwise comparisons were conducted to determine that the mean and medians for age were lower in the eclampsia group (26.14, 26) compared to the no-eclampsia group (26.99, 27). Considering the unbalanced sample sizes, the authors repeated the comparison with the no-eclampsia group and determined significance was maintained; however, the samples from the dataset did not appear to have a normal age distribution per the Anderson-Darling tests.

Tests were iteratively performed on various possible age splits between 13 and 43, concluding with significant difference ($p < 0.05$) between age splits 19-22 and 24-31 for eclampsia outcomes (Figure 6). While the non-adolescent statistics are beyond the scope of this paper, they speak to the need for continued research evaluating eclampsia across birthing person age. Upon determining a significant age split, over 100 variables were identified related to nutrition, specifically targeting magnesium and calcium-related nutrients, of which 26 variables were found to be significantly predictive of the eclampsia outcome variable.

Figure 6. Significance of Preeclampsia across Age



Of the 26 significant nutrient variables, “COLDCEREALQUAN” was the only significant interaction negatively correlated with eclampsia outcomes for adolescents, while it positively correlated with eclampsia outcomes for adults. The authors believe this finding to be connected to the fight for nutrients between fetus and developing birthing adolescent, which is not exacerbated in non-adolescent pregnancies as the birthing person is fully developed. ANCOVA’s were performed on nutrient covariates that did not have significant effects on eclampsia outcomes of which household income became a significant predicting outcome. There was no significant interaction between household income and age; however, nutrition variables were found to remain significantly predictive of eclampsia outcomes after accounting for income. The normalized effect sizes of income were also approximately twice that of nutrition variables. While nutrition variables continued to significantly predict eclampsia outcomes by themselves, they were no longer significantly predictive of eclampsia outcomes when income was taken into account.

Upon this finding, the authors created racial categorizations—White, Non-White Non-Hispanic Black, Non-Black Non-White Hispanic—and found racial categorizations were significant ($p < 0.01$) in predicting eclampsia outcomes. They then conducted a pairwise comparison to determine the only significant pairwise differences were between White and Non-White Non-Hispanic Black groups, of which the latter had no significant mean difference. Finally, an ANCOVA was run to find that there was no significant interaction between race and income when predicting eclampsia; therefore, race was not significantly predictive of eclampsia after accounting for income. ANCOVA’s were run across all derived categories and in all cases no significant effect ($p > 0.05$) of race was found after accounting for income. The authors do note, however, that the p-value when considering Black-Non-Black comparisons was lowest at 0.071 compared to 0.247 and 0.704. Some may interpret this result to mean that the Black-Non-Black categorization is more likely to be predictive of eclampsia.

DISCUSSION

While early nutrition analysis suggested a significant impact on eclampsia outcomes for adolescents, when adjusted for income, the variation became immaterial. The normalized effect of income was twice as significant as any other variable, specifically nutrition variables focused on

calcium and magnesium. From here the authors examined the risk of preeclampsia based on race, which appears significant ($p < 0.01$).

When this outcome was compared by income levels, again the variation became insignificant. The conclusion reached was most risk factors impacting adolescent pregnancy identified in the literature are less significant than income level. In the collaborative review of these leading risk factors (e.g., race and nutrients), all appeared to corroborate the literature until income levels in the dataset were applied. Based on this analysis, the assumptions of risk by race and diet among adolescent birthing people are mitigated by wealth and the inferred access it brings to higher-quality healthcare services and nutrition. Given the income reporting of household income for the observational study, the authors further assume adolescents in homes with higher earnings have access to better prenatal care.

This analysis has direct bearing on poorer pregnant people especially given the correlation between adolescent pregnancy and heightened risk of living in poverty. The study's financially poorer participants experienced higher risk of preeclampsia than wealthier participants, regardless of race or diet (considering food items high in calcium and magnesium). If policies are established to create healthcare equity, society will still be successful in seeing reduced diagnosis of preeclampsia across age, race, and income brackets even if wealth equity cannot be achieved.

Issues of wealth and equitable health access are further complicated by current challenges in the United States healthcare system. In October 2020, the National Maternal Health Research Network (NMHRN) presented data gathered from ongoing listening sessions geared towards developing a patient-centered outcomes research agenda aimed at addressing research gaps and examining opportunities for systems and policy changes. Five key themes emerged that directly link to the impact income has on maternal care access as determined by the aforementioned analyses (Figure 7):

Figure 7. NMHRN Symposium Key Findings

Major Themes That Emerged

Pregnancy: Misinformation adds difficulty to seeking prenatal and postpartum care.

Birth: Women of color experience disproportionate trauma in the healthcare system. Birth support resources such as doulas are essential to reducing traumatic birth experiences.

Postpartum Care: There is a major absence of postpartum care, which needs to be filled by education and services.

Issues Outside the Health System: COVID-19 has exacerbated financial constraints.

Visions for the Future: Increase clinician diversity, educational resources, and insurance coverage.



Given the aforementioned correlation between race and income, as well as age and preeclampsia, people of color experience disproportionate trauma navigating pregnancy and birthing care. From the listening sessions, many participants acknowledged the difficulty of advocating their healthcare needs in the face of aggressive and prejudiced-presenting clinicians. These participants felt as though they were not being listened to and their embodied health concerns were not taken seriously.

Such traumas are compounded in the absence of robust postpartum care, education, and services and the ongoing COVID-19 pandemic (Wolff et. al., 2020). As the world enters the third year of this global pandemic, housing and food insecurity remain high and many communities continue experiencing disproportionate insecurity as services become limited and increasingly restricted.

The direct recipients of this ongoing negatively shifting global healthcare climate are younger, poorer people. While adolescent pregnancy is linked to higher rates of preeclampsia, those adolescents living in high income households have greater access to healthier nutrition, more active lifestyles, greater food security, and greater healthcare access (Shaikh et. al., 2009). Financial security and greater access to equitable care, regardless of age, increases positive outcomes for infants and birthing people. There then is an additional burden placed on adolescents who experience inconsistencies in housing and food security given their age eligibility to receive social supports that could provide added benefit during pregnancy.

The aforementioned data solution reveals that while there are some relationships remaining to be explored between nutrition and diet, these are likely attributed to education, culture, training, and habits around food. While these factors remain relevant and worth pursuing, this implies that the most significant issue that remains is access to healthcare. Equitable wealth does not need to be immediately solved, but equitable access to healthcare is the most significant solution to improve outcomes for pregnant people.

Three brief policy proposals that can reduce negative encounters between adolescent pregnant people and maternal healthcare institutions are increased screening and health education, more affordable access to ethnically diverse foods, and increased access to social and communal services.

Due to preeclampsia's increased risk later in pregnancy (20 weeks or later), early screening, diagnosis, and intervention provides opportunities for clinicians to practice preventative care to both birthing person and fetus. Connected to early detection and intervention is increased access to care and health education. By providing increased care locations and increased education in those locations, adolescents can receive treatment, just care, and knowledge within and beyond healthcare clinics. This measure will have an even stronger impact if these additional sites are staffed with persons culturally representative of the communities in which the sites are located.

As with pregnant people of all ages, increased access to health insurance and social services like birth control is another recommendation given the impact income has on preeclampsia rates. For those adolescents experiencing financial insecurity, social and community services can meet daily needs that go unmet due to limited financial resources. Religious organizations, community shelters, and food banks are a few community organizations that can have direct positive bearing on adolescents' pregnancy and birthing experiences by providing security and support.

Lastly, addressing diet can have positive impacts on adolescent pregnancy and preeclampsia outcomes. Simple measures such as providing images of which foods are nutrient rich, along with recommended serving sizes is an excellent educational opportunity to ensure

adolescents receive enough nutrients for their and their fetuses' development. Nutritionists providing information on ethnically diverse foods can also expand the amount of nutrients pregnant adolescents receive. By expanding food options, adolescents of color have increased accessibility to nutrient-rich foods that they can find both affordably and in their communities.

CONCLUSION

Diet is modifiable and can greatly improve pregnancy and birth outcomes across age demographics. But more than diet, financial security and equitable access to healthcare have greater positive implications on birthing outcomes. Higher incomes reduce preeclampsia outcomes among nulliparous adolescent birthing people and strengthen infant birthing outcomes. Diet, financial status, and access to healthcare must be taken into consideration when providing care for adolescent pregnant people. Upon encountering patients experiencing challenges in any of these areas, robust educational and social services should be provided to reduce traumatic encounters with the healthcare system and increase positive pregnancy and birthing experiences. While adolescent pregnancy remains a considerable public health concern, simple policy changes can be put in place to reduce adverse pregnancy complications like preeclampsia.

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REFERENCES

- Aliyu, M.H., Luke, S., Kristensen, S., Alio, A., & Salihu, H. (2010). Joint Effect of Obesity and Teenage Pregnancy on the Risk of Preeclampsia: A Population-Based Study. *Journal of Adolescent Health*. 26(1), 77-82.
- Carson, M., & Gibson, P. (2018). Hypertension and Pregnancy. *Medscape*. Retrieved from <https://emedicine.medscape.com/article/261435-overview#a4>.
- Carty, D., Delles, C., & Dominiczak, A. (2008). Novel Biomarkers for Predicting Preeclampsia. *Trends in Cardiovascular Medicine*. 18(5), 186-194.

- Darroch, J., Woog, V., Bankole, A., & Ashford L.S. (2016). Adding it up: Costs and benefits of meeting the contraceptive needs of adolescents. *New York: Guttmacher Institute*. Retrieved from <https://www.guttmacher.org/report/adding-it-meeting-contraceptive-needs-of-adolescents>.
- Data Coordinating and Analysis Center at RTI International. (2019). *Database Documentation for Public Release of the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-be (nuMoM2b)*. (1st ed.). NICHD.
- Gernand, A.D., Schulze, K.J., Stewart, C.P., West, Jr., K.P., & Christian, P. (2016). Micronutrient deficiencies in pregnancy worldwide: health effects and prevention. *Nat Rev Endocrinol*. 12(5), 274-289.
- Haas, D.M., Parker, C.B., Wing, D.A., et al. (2015). A description of the methods of the Nulliparous Pregnancy Outcomes Study: monitoring mothers-to-be (nuMoM2b). *Am J Obstet Gynecol*. 212(539), 1-24.
- Kawakita, T., Wilson, K., Grantz, K., Landy, H.J., Huang, C., & Gomez-Lobo, V. (2016). Adverse maternal and neonatal outcomes in adolescent pregnancy. *Journal of Pediatric Adolescent Gynecology*. 29(20), 130-136.
- Kingston, D., Heaman, M., Fell, D., & Chalmers, B. (2012). Comparison of adolescent, young adult, and adult women's maternity experiences and practices. *Pediatrics*. 129(e), 1228–1237.
- Lee, M., Suhng, L., Lu, T., Chou, M. (1998). Association of parental characteristics with adverse outcomes of adolescent pregnancy. *Family Practice*. 15, 336-342.
- Martin, J.A., Hamilton, E.B., Osterman, J.K., Curtin, S.C., & Matthews, T.J. (2013). Centers for Disease Control and Prevention National Center for Health Statistics National Vital Statistics System. Births: final data for 2012. *Natl Vital Stat Rep*. 62(9), 1–67.
- NICHD Pregnancy and Perinatology Branch. (2021). Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be (nuMoM2b). *NICHD*. Retrieved 4/4/2022. from <https://www.nichd.nih.gov/research/supported/nuMoM2b>.
- Parra-Pingel, P.E., Quisiguiña-Avellán, L.A., Hidalgo, L., Chedraui, P., & Perez-Lopez, F.R. (2017). Pregnancy outcomes in younger and older adolescent mothers with severe preeclampsia. *Adolesc Health Med Ther*. 8, 81-86.
- Rosales-Ortiz, S; Rodríguez, OS; Borbolla-Ramos, M; García-Pérez, KD. (2019). Adolescence and Preeclampsia. In (Ed.), *Prediction of Maternal and Fetal Syndrome of Preeclampsia*. IntechOpen. Retrieved from <https://doi.org/10.5772/intechopen.86147>
- Rounds, K., Sneed, C. (2014). Adolescent Pregnancy. In A. Gitterman (Ed.), *Handbook of Social Work Practice with Vulnerable and Resilient Populations* (3rd ed., pp. 205–226). Columbia University Press. <http://www.jstor.org/stable/10.7312/gitt16362.14>
- Shaikh, U., Byrd, R., & Auinger, P. (2009). Vitamin and mineral supplement use by children and adolescents in the 1999-2004 National Health and Nutrition Examination Survey: relationship with nutrition, food security, physical activity, and health care access. *Arch Pediatr Adolesc Med*. 163(2), 150-157.
- Wolff, L., & jacobs, s. (2020). NMHPN: Partnering for justice in maternal health. *Virtual Symposium: Moving towards Justice in Maternal Health A Roadmap for Justice*.
- World Health Organization. (n.d.). *Adolescent Health*. Retrieved from https://www.who.int/health-topics/adolescent-health#tab=tab_1