NIH Collaboratory Ethics and Regulatory Core: Initial Consultation Call
Maternal OutcoMes Program: Testing Integrated Maternal Care Model Approaches to Reduce Disparities in Severe Maternal Morbidity
(MOMs Chat & Care Study)
November 20, 2023; 11:00 am-12:00 pm ET (via Zoom)

Attendees:
- Core, Coordinating Center, and NIH: Joe Ali (Johns Hopkins University), David Magnus (Stanford University), Kevin McBryde (NCCIH), Stephanie Morain (Johns Hopkins University), Pearl O'Rourke (retired), Caleigh Propes (Johns Hopkins University), Tammy Reece (Duke University), Kayte Spector-Bagdady (University of Michigan), Kevin Weinfurt (Duke University), Dave Wendler (NIH)
- Study team: Stephanie Fitzpatrick (Feinstein Institute for Medical Research, Northwell Health), Challace Pahlevan-Ibrekic (Institute for Health System Science, Northwell Health)

AGENDA ITEMS	DISCUSSION	ACTION ITEMS	OWNER
Brief review of the trial	Meeting attendees received the Research Strategy, Data and Safety Monitoring Plan, and Protection of Human Subjects Plan for MOMs with the meeting agenda (see supplementary material attached). Stephanie Morain facilitated introductions and the discussion. The MOMs team members present were Stephanie Fitzpatrick (principal investigator) and Challace Pahlevan-Ibrekic (director of regulatory affairs for the Institute of Health System Science at Northwell Health). **Project overview**: Stephanie Fitzpatrick gave an overview of the project, for which both planning and implementation are supported through an R01 grant award. The goal of MOMs is to test the effectiveness of an integrated care model approach at 2 levels of intensity ("low touch" and "high touch") designed to facilitate timely, appropriate care for Black birthing people to reduce their risk for severe maternal morbidity. **Healthcare system partners**: Northwell Health **NIH Institute Providing Oversight**: National Institute of Nursing Research (NINR)		

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	Study design: The study is proposed to be a 2-arm pragmatic trial of adults at high risk for severe maternal morbidity. Participants will be assigned by individual randomization to either a low-touch or high-touch version of the MOMs integrated care model. The low-touch program will consist of standard-of-care procedures currently offered in the partnering healthcare system (including support via an automated conversation system, or chatbot, that will send alerts to a centralized care team to trigger care pathways as clinical or other issues come up, weekly check-ins to facilitate appointment scheduling and other services to help prevent morbidity in the early postpartum period, etc). Research-driven procedures in the low-touch study arm will include receipt of a fitbit wearable activity monitor. The high-touch program will consist of all of the features of the low-touch program (ie, delivery of all current standard-of-care procedures and the fitbit), plus a home blood pressure monitor and additional support and contact in the prenatal period through 12 biweekly sessions with a nurse or other care coordinator to facilitate chronic disease prevention and management. **Outcomes**: The primary outcome is severe maternal morbidity as defined by the Centers for Disease Control and Prevention. Other outcomes include preeclampsia diagnosis and initiation of treatment, changes in perceived social support domains, patterns of physical activity, and implementation outcomes. The chatbot is a preexisting resource available to all patients in the participating healthcare system. In this established program, conversation prompts flagged by the chatbot go directly to a centralized care team; the care team member then calls the patient for assessment before referring them to appropriate care or other services. Flags include clinical, behavioral health, and social need metrics or concerns. The centralized care team will then use established clinical pathways to assess the patient's situation and refer them to appropriate care. The chatbot program itself does not identify appropriate pathways but simply alerts the clinical team that an issue needs attention. The chatbot is not the focus of this study and will not be tested; it is offered to both study arms because it is a current standard-of-care practice for maternal health support in the partnering healthcare system.		
Status of IRB approval	The study will be conducted in a single healthcare system and will use the Northwell Health IRB. IRB approval has not yet been received.		

AGENDA ITEMS	DISCUSSION	ACTION ITEMS	OWNER
Risk (Does the project meet regulatory criteria for being considered minimal risk?); and consent (planned processes for relevant subjects)	The study team anticipates that the project will meet the regulatory criteria to be considered minimal risk. The chatbot is not being evaluated as part of this research. However, if the local IRB considers use of the chatbot to be a research-driven procedure, the study team anticipates that the use will meet FDA criteria for nondevice clinical decision support. The study team will identify potentially eligible patients using the electronic health record, will send them letters and study information, and will follow up by telephone after 7 days for a recruitment call. Patients who are interested and eligible will undergo a verbal consent process, complete baseline questionnaires, and be randomly assigned to a study arm.		
Privacy (including HIPAA)	The group discussed questions related to the commercial vendor that developed the chatbot program; the reference dataset used to develop the program and its relevance to the study population; and whether and how patient data will flow back to the vendor and potentially be used to improve the product. The study team will confirm whether any data from Northwell Health will be provided to the vendor. • After the meeting, the study team confirmed that they will meet with the clinical team and the chatbot developer in early January to discuss data sharing, data generated, and data/information used for product development.		
Monitoring and oversight	A data and safety monitoring board is not required. The study will have an independent safety monitor.		
Issues beyond this project (regulatory and ethics concerns raised by the project, if any)	None.		
Other matters	The study team raised a question about whether the interventionists in the study (coordinators, nurses) will need to complete human subjects research training, even though they will simply be performing tasks they already perform as part of their regular clinical practice. It was noted that this may vary by institution, but in this case it seems likely that they will not need to complete additional training. Pearl O'Rourke asked whether the clinical personnel receiving the chatbot alerts will be aware of		

AGENDA ITEMS	DISCUSSION	ACTION ITEMS	OWNER
	which patients are enrolled in the study, as this could help determine whether they are acting strictly in a clinical care capacity. • After the meeting, the study team confirmed that the care team will not be made aware of which patients are enrolled in the study. They will follow standard protocol for the MOMs program. The group discussed a number of questions related to what data will be entered into the chatbot by any connected devices, such as the fitbit. There especially was concern about the types and quantity of data that a linked fitbit might automatically load into the chatbot and how that data will be shared, given the potential privacy considerations. There was a related concern about what data generated by the fitbit might be also be shared with Fitbit, Inc. • After the meeting, the study team confirmed that they will meet with the clinical team and the chatbot developer in early January to discuss data sharing, data generated, and data/information used for product development.		

SPECIFIC AIMS

There is a maternal health crisis in the US. Severe maternal morbidity (SMM) affects 60,000 birthing people per year, increasing the risk for rehospitalization post-delivery, disability, and maternal mortality. Black birthing people are two times more likely to experience SMM than non-Hispanic White birthing people. Preeclampsia is a leading cause of SMM and disproportionately affects Black birthing people. Most cases of SMM are avoidable if timely, appropriate care is provided. Also, implementing self-management behaviors during pregnancy and postpartum, such as self-monitoring blood pressure and regularly engaging in physical activity, can help reduce risk for pre-eclampsia and SMM. Health-related unmet social needs are barriers to receiving timely care and engaging in self-management behaviors, therefore, exacerbating risk for SMM. Thus, there is a need for interventions that involve close clinical monitoring of high-risk birthing people, timely connection to clinical and social services, and self-management support to address inequities in SMM.

The Maternal OutcoMes (MOMs) Program implemented at Northwell Health, the largest healthcare provider in New York state, is an effective integrated care approach that identifies and supports high-risk birthing people. MOMs, led by a team of care management coordinators (CMC) and registered nurses (RN), includes close clinical and behavioral health monitoring via chatbot and phone-based check-ins; connection to a 24/7 nurse-led call center; and navigation to clinical and social services for 30 days post-delivery. Among 2500 participants from 2020-2021, **the MOMs Program significantly reduced risk for SMM-related hospital admissions 30-days post-delivery by 77% among Black participants**. These preliminary findings are promising; however, the long-term effectiveness needs to be established. Furthermore, because SMM can occur throughout the birthing continuum, examining the feasibility and effectiveness of extending the MOMs Program to the prenatal period is warranted.

The purpose of this study is to test the effectiveness of an integrated care model approach at two different levels of intensity designed to facilitate timely, appropriate care for high-risk Black birthing people and reduce risk for SMM. Black birthing people with an Obstetrics-Comorbidity Index Score ≥ 3 and/or a history of pre-eclampsia will be identified via the electronic health record (EHR) and 674 will be recruited and randomized during the first trimester to one of two study arms: MOMs High-Touch (MOMs-HT) vs. MOMs Low-Touch (MOMs-LT). MOMs-HT will consist of close clinical and behavioral health monitoring via chatbot technology and navigation to timely care and services by the MOMs team throughout the prenatal and postpartum periods; 12 bi-weekly self-management support calls with a MOMs CMC or RN during the prenatal period; and 4 weekly postpartum clinical check-in calls with navigation by the MOMs team immediately post-delivery. MOMs-LT will also include clinical and behavioral health monitoring via the chatbot along with navigation to services by the MOMs team and 4 weekly postpartum clinical check-in calls with navigation. SMM (primary) will be based on the CDC's 21 indicators, and along with diagnosis of preeclampsia (secondary), will be captured using the EHR. Questionnaires will be administered to measure domains of social support (secondary). Physical activity behaviors (exploratory) will be assessed via survey and Fitbit. We propose the following aims:

Aim 1: Compare MOMs-HT to MOMs-LT on the incidence of SMM at the time of labor and delivery. *We hypothesize that participants randomized to the MOMs-HT arm will have a significantly lower incidence of SMM than those randomized to MOMs-LT at labor and delivery.*

Aim 1a: Compare study arms on the incidence rate of SMM-related hospital admissions at 1-month and 1-year postpartum.

Aim 2: Compare study arms on the rate of preeclampsia diagnosis during the prenatal period.

Aim 3: Examine the effect of the two study arms on perceived social support domains (informational, emotional, and tangible) from enrollment to 1-month and 1-year postpartum.

Aim 4: Explore the effect of each study arm on patterns of engagement in physical activity from study enrollment to 1-year postpartum and subsequent association with maternal health outcomes.

This proposal is highly aligned with the goals of RFA-NR-23-002, *Advancing Integrated Models of Care to Improve Pregnancy Outcomes among Women Who Experience Persistent Disparities*, in that it aims to understand how to feasibly implement an effective and sustainable integrated care approach to address SMM disparities. The longitudinal design of this study, including activity data collection throughout the birthing continuum, will provide the opportunity to examine mechanisms. A partnership among Northwell Health researchers, clinicians and the Center for Maternal Health as well as Mama Glow (nonprofit doula organization) will ensure enhanced support for Black birthing people and foster the implementation of sustainable solutions to address maternal health and healthcare inequities.

SIGNIFICANCE

Severe maternal morbidity (SMM) disproportionately affects Black birthing people and is an urgent health equity priority. The Centers for Disease Control & Prevention (CDC) defines SMM as "unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a birthing person's health."[1] SMM increases the risk for rehospitalization post-delivery,[2] disability,[3] and maternal mortality and affects 60,000 birthing people per year.[4] Although most cases of SMM are diagnosed at labor and delivery, 1 in 7 birthing people experience SMM during postpartum.[5] Black birthing people have the highest rate of SMM throughout the birthing continuum[6] and are two times more likely to experience SMM than non-Hispanic White birthing people,[7] even with similar economic backgrounds and medical coverage.[8,9] There are patient-, health system-, and community-level factors that contribute to SMM disparities;[10] however, most cases of SMM are avoidable if timely, appropriate care is provided.[1] There is a need for effective integrated care approaches that involve identifying and managing risk factors for SMM throughout the birthing continuum and providing timely connection to clinical and social care services.

Hypertensive disorders in pregnancy such as preeclampsia are the leading cause of SMM and have consequences for both the birthing person and the baby.[11-15] Preeclampsia occurs when the birthing person who previously had normal blood pressure develops high blood pressure and potentially proteinuria or other problems after 20 weeks of pregnancy. It is estimated that preeclampsia occurs in 4% of all pregnancies in the US.[16] Black birthing people are at greatest risk and are almost 3 times more likely to experience preeclampsia than non-Hispanic White birthing people.[15,17,18] Risk factors for preeclampsia include history of preeclampsia, chronic conditions (hypertension and diabetes), and body mass index ≥ 35.[19] Blood pressure monitoring early during pregnancy in the clinic and at home helps with identifying preeclampsia.[20-23] Furthermore, taking low-dose aspirin daily after 12 weeks of pregnancy has been shown to reduce the risk for preeclampsia among high-risk birthing people and is a Grade B recommendation from the US Preventive Services Task Force.[16,24] A previous study demonstrated that timely treatment of elevated blood pressure with antihypertensive medications during pregnancy was associated with a significant 72% reduction in the risk for SMM.[25] Therefore, monitoring blood pressure and providing timely care is critical for reducing risk for preeclampsia and addressing SMM disparities.

Social support may help to prevent delays in seeking care and reduce risk for complications. Previous research suggests that birthing people who experience SMM have smaller support networks and lower satisfaction with the perceived support compared to birthing people who don't experience SMM.[26] Furthermore, studies suggest that lack of social support during pregnancy is significantly associated with poor mental health during pregnancy and postpartum,[27,28] which increases risk for SMM and other complications.[29] For example, inadequate support in terms of maternal health education or feeling unsupported emotionally may lead to birthing people ignoring signs and symptoms of risk factors for SMM and delay seeking care. In a community listening session conducted in 2018 by the New York State Department of Health with 244 participants, birthing people emphasized the need for social support throughout the birthing continuum to address maternal health inequities.[30] They particularly mentioned the importance of receiving forms of informational, emotional, and tangible support from the clinical care team as well as traditional health workers. Thus, integrated maternal care models should be patient-centered and foster a sense of social support to facilitate receipt of timely, appropriate care and empower birthing people to manage their health during the pregnancy and postpartum periods.

In addition to receiving timely clinical care, **engaging in self-management behaviors has been associated with improved maternal health outcomes.** Self-monitoring (e.g., blood pressure, blood glucose, weight, dietary intake, physical activity) increases health knowledge, empowerment, and self-efficacy among birthing people.[31-33] Furthermore, medication adherence, healthy eating, and regular engagement in physical activity during pregnancy reduces risks associated with SMM such as obesity and elevated blood pressure as well as other adverse maternal and infant outcomes.[16,34-38] In particular, **higher levels of physical activity during pre-pregnancy or early in pregnancy has been shown to reduce risk for preeclampsia by ~20-35% in systematic reviews and meta-analyses.**[37,39,40] National and international guidelines recommend that birthing people get at least 150 minutes of moderate-intensity aerobic physical activity per week.[41] However, studies suggest that, overall, less than 25% of birthing people meet this recommendation during pregnancy,[41] and adherence is likely to be even lower among Black birthing people.[42] Thus, a large number of Black birthing people may not be experiencing the health benefits of physical activity during the prenatal or postpartum

periods. Exploring barriers to physical activity and the effect of an integrated care approach on patterns of physical activity behaviors throughout the birthing continuum, may provide an opportunity to refine future physical activity interventions to optimize maternal health outcomes, especially among Black birthing people.

Health-related social needs exacerbate maternal health inequities and create challenges to engaging in self-management behaviors.[43] Both lack of medical coverage and transportation can delay and interrupt timely prenatal care as well as limit attendance at postpartum visits, which is a critical transition period to address risk factors prior to the next pregnancy.[10,44,45] Food insecurity has also been associated with pregnancy complications, increased stress and anxiety, and poor health outcomes for the birthing person and the baby.[46,47] Poor access to affordable housing increases risk for SMM, particularly among birthing people with low levels of education.[48] The presence of social needs is also associated with increased risk for diabetes and cardiovascular disease, both risk factors for SMM.[49,50] Furthermore, experiencing social needs makes it harder to engage in physical activity, healthy eating, and other self-management behaviors.[51-56] Therefore, monitoring and addressing clinical, behavioral health, and social needs is essential for a comprehensive, integrated maternal care approach.

Preliminary Work – Maternal OutcoMes (MOMs) Program. In 2020, we launched the MOMs Program at Northwell Health, the largest healthcare provider in New York state. Applying evidence-based protocols for transitional care management after hospital discharge,[57-59] MOMs is a patient-centered, integrated care model approach that involves identifying and supporting high-risk birthing people over 30 days post-delivery. More specifically, MOMs consist of: a) identifying high-risk birthing people using clinical diagnoses documented in the electronic health record (EHR); b) close clinical and behavioral health monitoring via a chatbot and 4 weekly phone check-ins; c) access to a 24/7 nurse-led call center; d) navigation to obstetric and specialty care (e.g., cardiology, behavioral health), and emergency services; e) home visits (if needed) with a nurse practitioner to monitor and support birthing person's and baby's health as well as provide training on breastfeeding; and f) connection to social services and community-based resources to address social needs. MOMs is delivered by a team of care management coordinators (CMCs – non-clinical staff), registered nurses (RNs), and a nurse practitioner that works closely with the OB/GYN, cardiology, behavioral health, and other service lines as well as the Medicaid Health Home to support high-risk birthing people. From 2020 to 2021, there were ~2500 racially and ethnically diverse, high-risk birthing people enrolled in the MOMs Program.[60] Participation in MOMs was associated with an overall 56% reduction in 30-day post-delivery hospitalizations related to indicators of SMM. **Among Black birthing people, there was a 77% reduction in SMM-related hospitalizations.** Based on findings from focus groups we conducted with 25 former MOMs participants (including 10 Black birthing people), the MOMs Program was essential in helping them to navigate their clinical care during postpartum in a timely manner (e.g., scheduling medical appointments), accessing needed services (e.g., signing up for WIC and SNAP), and providing self-management support (e.g., reminder to monitor blood pressure and teaching strategies to increase medication adherence).

Scientific justification. There is a maternal health crisis in the US that disproportionately affects Black birthing people. SMM and risk factors for SMM, such as preeclampsia, are preventable if timely, appropriate care is provided, birthing people are supported in engaging in self-management behaviors, and health-related social needs are addressed. The MOMs Program was designed to identify and support high-risk birthing people to reduce risk for SMM during early postpartum. Preliminary data of the MOMs Program suggest promising findings, especially among Black birthing people. However, the long-term effectiveness needs to be established. Furthermore, because SMM can occur throughout the birthing continuum, with the highest rates during labor and delivery,[5] examining the feasibility and effectiveness of extending the MOMs Program to the prenatal period is warranted. Therefore, the purpose of this study is to compare the effectiveness of the original MOMs Program to a high-touch version that includes more intensive support and care navigation during the prenatal period on reducing risk for SMM among Black birthing people long-term.

INNOVATION
Recent initiatives to reduce risk for SMM involve an integrated care model similar to some elements of the MOMs Program.[10] However, there are several features of this study that will contribute novel data to further expand the work in maternal health equity.
- Longitudinal study design. Although intervening during both the prenatal and postpartum periods is not particularly novel, assessing the primary outcome of SMM at labor and delivery, early postpartum, and

1-year postpartum provides a unique opportunity to examine the effectiveness of MOMs across the pregnancy care continuum. Furthermore, few studies have been able to objectively monitor physical activity throughout the birthing continuum.[61] In this proposed study, participants will be asked to wear an activity monitor (i.e., Fitbit) from enrollment (no later than 12 weeks gestational age) to 1-year postpartum. With this approach, we will be able to examine the feasibility of capturing longitudinal activity data in a high-risk birthing population and contribute new knowledge regarding patterns of physical activity behaviors (e.g., frequency, duration, and intensity) and how these patterns are associated with maternal health outcomes.

- <u>SMM as a primary outcome.</u> To date most maternal health intervention studies focus on a single indicator of SMM (e.g., eclampsia) or other pregnancy-related complications (e.g., preterm births, low birthweight, caesarean delivery). This approach limits our understanding about how to address racial and ethnic disparities in the overall SMM prevalence, a major risk factor for maternal mortality. In this study, SMM will be based on having a diagnosis of one or more of the CDC's 21 indicators.[4] This way we will be able to examine the effectiveness of MOMs based on SMM as a binary outcome (yes or no).

- <u>Use of a chatbot to facilitate support of high-risk birthing people (Figure 1).</u> Part of the MOMs Program is facilitated by OB (obstetrics)-Chat, a personalized care digital conversation chatbot delivered via the Conversa platform. At Northwell Health, birthing people are enrolled in OB-Chat when they initiate prenatal care. OB-Chat is accessible on any electronic device (i.e., smartphone, tablet, or computer). During the

Figure 1. Northwell OB-Chats

prenatal and postpartum periods, birthing people will receive a weekly OB-Chat via text message or email that provides educational tools and resources as well as the ability to track blood pressure. If the birthing person indicates any moderate to severe clinical, behavioral, or social health concerns or enters an elevated blood pressure, the chatbot is designed to escalate this concern to the 24/7 nurse led call center within the MOMs Program who will then follow-up via phone call. In 2022, over 1500 birthing people at Northwell Health activated OB-Chat and almost 80% completed one or more weekly chats. The use of chatbots is still quite novel, but a growing approach in maternal healthcare as they could help to expand the reach of low-touch interventions (e.g., patient education) while helping to identify and triage those that need a more intensive intervention.[62-65]
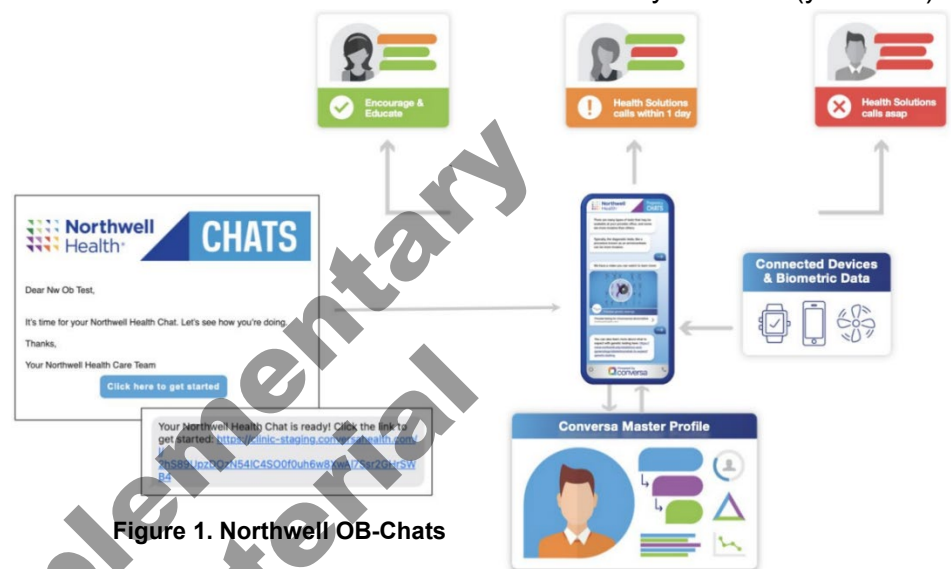
APPROACH
Study Overview
This is a pragmatic, randomized clinical trial designed to compare the effectiveness of an integrated care approach at differing levels of intensity on reducing the prevalence of SMM among high-risk Black birthing people. High-risk Black birthing people will be identified using the EHR and 674 birthing people will be recruited and randomized during the first trimester to one of two study arms: MOMs High-Touch (MOMs-HT) vs. MOMs Low-Touch (MOMs-LT). MOMs-HT will consist of close clinical and behavioral health monitoring via OB-Chat and navigation to timely care and services by the MOMs team as needed throughout the prenatal and postpartum periods; 12 bi-weekly check-in and self-management support calls with a MOMs CMC or RN during the prenatal period; and 4 weekly postpartum clinical check-in calls with navigation by the MOMs team immediately post-delivery. MOMs-LT will also include clinical and behavioral health monitoring via OB-Chat along with navigation to services by the MOMs team as needed and 4 weekly postpartum clinical check-in calls with navigation. SMM at labor and delivery (primary) and at 1-month and 1-year postpartum (secondary) will be based on the CDC's 21 indicators[4] with diagnoses extracted from the EHR. Diagnosis of preeclampsia during the prenatal period (secondary) will also be captured using the EHR. Questionnaires will be administered to

measure domains of social support (secondary). Physical activity behaviors (exploratory) will be assessed via survey and wearable activity monitor (i.e., Fitbit).

Research Team

Our racially, ethnically, and gender diverse research team includes experts in clinical trials, maternal health and healthcare, health disparities, chronic conditions, implementation science, self-management interventions, physical activity, and biostatistics. This strong team is well-poised to pioneer the proposed large, pragmatic, randomized clinical trial. Team structure and coordination of efforts are further described in the **Overall Structure of the Study Team attachment**.

- Stephanie L. Fitzpatrick, PhD (Principal Investigator) is an Associate Professor in the Institute of Health System Science (IHSS) within the Feinstein Institutes for Medical Research (FIMR) and in the Zucker School of Medicine at Northwell Health. As a behavioral scientist and clinical health psychologist, she has over a decade of experience in behavioral intervention clinical trials for obesity, diabetes, and hypertension, all conditions that increase risk for SMM. Dr. Fitzpatrick has served as PI or Co-I on several NIH- and PCORI-funded observational and randomized clinical trial studies conducted in large health systems with racially, ethnically, and socioeconomically diverse patient populations (R01DK115237, R34DK119853, R01NR020305, R01MD016068, R01DK098256, HSD-1603-34987, CDRN-1306-0468). She is a former fellow in the NCI-funded Mentored Training for Dissemination & Implementation Research in Cancer (MT-DIRC) and has experience with leading large, multidisciplinary teams. She is also currently an active member of the Northwell Health Center for Maternal Health and a member of the antepartum, peripartum and postpartum workgroups. In preparing this grant application, Dr. Fitzpatrick worked closely with each study team member and clinical departments to ensure the relevance and appropriateness of the research question and study design to ultimately improve maternal health equity.

- Felicia Hill-Briggs, PhD (Co-Investigator) is the Vice President for Prevention, Professor and Associate Director of the IHSS within FIMR, and the Simons Distinguished Chair in Clinical Research at the Zucker School of Medicine at Northwell Health. She is a behavioral scientist, clinical psychologist, and health equity researcher whose research focuses on effective individual- and health system level intervention design and implementation with populations that experience health inequities. She has over 20 years of continuous funding as PI or Project Lead on NIH, PCORI, and foundation funded grants, including as Evaluation Lead on Centers for Medicare and Medicaid Services demonstration projects and innovation awards to improve health care system outcomes and value. Drs. Hill-Briggs and Fitzpatrick have previously worked together on self-management intervention studies and have co-authored several publications.

- Trever Ball, PhD (Co-Investigator) is the Director of Clinical Research for Health Solutions, Population Health Management at Northwell. He leads the design and evaluation of value-based care management programs at Northwell, including the MOMs Program. Dr. Ball served as a Co-I and lead biostatistician on the randomized clinical trial, Northwell Health Visits (NCT03887910), that helped to establish the MOMs Program, and conducted the analyses in the recent publication of the findings from the MOMs Program.[60]

- Wanda Nicholson, MD, MPH, MBA (Co-Investigator) is the Senior Associate Dean of Diversity, Equity and Inclusion and Professor of Prevention and Community Health at George Washington University – Milken Institute School of Public Health. As a practicing obstetrician and clinical researcher, Dr. Nicholson has expertise in addressing adverse pregnancy outcomes, research experience with RCTs and observational studies (CARDIA, ARIC) enrolling pregnant and postpartum birthing people, and comparative effectiveness research to improve birthing people's health across the lifespan. As current Vice Chair of the US Preventive Services Task Force, she helped to develop the recent recommendation on screening for hypertension disorders of pregnancy and contributed to the initial recommendation on low dose aspirin and pre-eclampsia. She has adapted evidence-based interventions (PREMIER, DPP) proven effective in adults for pregnant/postpartum birthing people at risk for CVD and with a particular focus on Black birthing people. She was lead Co-I on a NICHD study (Pregnancy, Eating and Attributes Study) enrolling 450 birthing people to assess dietary quality and self-regulation on gestational weight gain and postpartum weight at 1 year. As an institutional PI for a PCORI/AHRQ-funded comparative effectiveness study investigating gynecologic conditions, psychosocial factors and health-related quality of life, she enrolled 560 birthing people (50% NHB) from central and eastern North Carolina, with 80% retention at year 2 follow-up.

- Ciaran Friel, PhD (Co-Investigator) is an Assistant Professor in IHSS within FIMR at Northwell Health. He is a behavioral scientist and exercise physiologist with expertise in using technology to monitor and influence health behaviors with a primary focus on physical activity. His research focuses on the role of wearable technology in the promotion of physical activity and reduction in sedentary behaviors.
- Codruta Chiuzan, PhD (Co-Investigator) is an Associate Professor and Co-Lead of Quantitative Intelligence in IHSS within FIMR at Northwell Health. She is a NIH-funded biostatistician and methodologists with expertise in analyzing longitudinal data from wearables (P30AG063786), developing innovative early-phase adaptive trial designs, and applying statistical methods using real world data for evidence-based decision making and shared learning.

Study Site
The study will take place at Northwell Health, which serves over 8 million people residing in urban, suburban, and rural communities throughout Long Island, New York City, and Westchester New York and represents a broad spectrum of racial, ethnic, and socioeconomic diversity. Northwell Health is comprised of 22 hospitals and 850 ambulatory sites, including over 50 OB/GYN practice sites. There are approximately 30,000 births across Northwell hospitals each year, roughly 1% of all births in the US. As the largest healthcare provider in New York, Northwell Health is the ideal healthcare setting in which to conduct this study. To date, the prevalence of SMM among deliveries at Northwell are over three times the national average (4.9% vs. 1.4%[7]) with the higher prevalence among Black birthing people (6.2%). To address these disparities, Northwell recently initiated the Center for Maternal Health with specific workgroups to address patient-, health system-, and community-level factors during the pre-pregnancy, antepartum, and postpartum periods. In addition, the Obstetrics team at Northwell has created an extensive electronic database and surveillance platform to monitor pregnancies, births, risk for SMM, incidence of SMM and related diagnoses, and mortality (i.e., the Perinatal Data Center). We will leverage this infrastructure to successfully complete this proposed study.

Participants
Because we want to identify birthing people early and prevent preeclampsia, we are defining high risk for SMM as birthing people with a history of preeclampsia and/or an Obstetrics-Comorbidity Index (OB-CMI) risk score ≥ 3. As previously mentioned, birthing people who experienced preeclampsia during a previous pregnancy are at higher risk for having preeclampsia at a future pregnancy[19] and, therefore, are at increased risk for SMM.[11] The OB-CMI is a validated screening tool that has been shown to be significantly predictive of SMM.[66] Although the OB-CMI risk score was originally developed based on data at labor and delivery, many of the risk factors (e.g., preeclampsia, severe obesity, maternal age > 35, previous cesarean delivery, multiple gestation, and previous fetal death) can be identified or diagnosed early during the prenatal period.[66] Based on Northwell birthing data from January 2021 to March 2022, an OB-CMI risk score ≥ 3 was associated with an increase in SMM prevalence at delivery (p<.001).

Eligible birthing people will be identified using the EHR. We will recruit and enroll birthing people who meet the following criteria: a) age 18 or older; b) self-identify as Black/African American; c) pregnant with gestational age no higher than 12 weeks; d) have an OB-CMI risk score ≥ 3 and/or history of preeclampsia; e) primary language is English or Spanish; and f) are receiving obstetrics care at a Northwell Health Physician Partners OB practice site. Birthing people who are not able to provide informed consent due to cognitive or psychiatric impairment will be excluded. Because this is a pragmatic trial, exclusion criteria are minimal.

From January 2021 to mid-2022, 4,229 Black birthing people gave birth at a Northwell Health hospital. Among this population, 38% (n = 1592) would be potentially eligible for this trial given they had an OB-CMI risk score ≥ 3. Furthermore, 31% experienced preeclampsia, 24% were age 35-39, 16% had a BMI ≥ 40, and 14% had a prior caesarean delivery.

Recruitment and Retention Plan
We will leverage the Northwell Health Perinatal Data Center (registry of prenatal, birth, and postpartum EHR data) to develop and refine an algorithm to identify potentially eligible birthing people based on the inclusion criteria. This algorithm will be run daily to populate a recruitment list. Research coordinators will mail and email recruitment letters to potentially eligible participants, which will be followed by recruitment phone calls. This is approach is currently, successfully used by the MOMs Program, which has enrolled 3500 birthing people (~25% Black) to date. During these calls, research assistants will give an overview of the study, screen to

confirm eligibility, obtain informed consent, and if eligible, randomize the participant and administer baseline questionnaires. We will recruit over the course of 27 months and aim to recruit ~25 participants per month to meet our recruitment goal (N = 674). Randomization will be at the individual participant level at a 1:1 ratio. The PI, Co-Is (with the exception of Drs. Ball and Chiuzan) and data collectors will be blinded to randomization assignment. Participants and the MOMs team will not be blinded.

To retain Black birthing people in the study, we will use some of the effective approaches described by Yancey et al.[67] for retaining racial and ethnic minoritized participants in research: a) maintaining regular contact with participants via OB-Chat, clinical check-ins, and self-management support calls; b) assign a CMC or RN that speaks the participant's preferred language or make sure an interpreter is available; and c) collect family and friend contact information in case the participant is unreachable. Each participant will also receive a financial incentive ($25) at baseline and at 1-month and 1-year postpartum for completing questionnaires. Additionally, participants will be able to keep their Fitbit after the study ends.

Conceptual Framework

The integrated care model being tested in this study is informed by the "Three Delays Model."[68] The "three delays model" theorizes that severe maternal morbidity and mortality occur because of delays in three phases: 1) birthing person and/or their family delay in deciding to seek care; 2) there is a delay in reaching a healthcare facility with clinicians and staff trained in obstetrics and/or a perinatal clinician; and 3) there is delay in receiving timely and appropriate evidence-based care. Thus, the intervention components across both study arms are designed to prevent these delays that occur at the patient and health system levels and address clinical and social needs immediately (Figure 2).
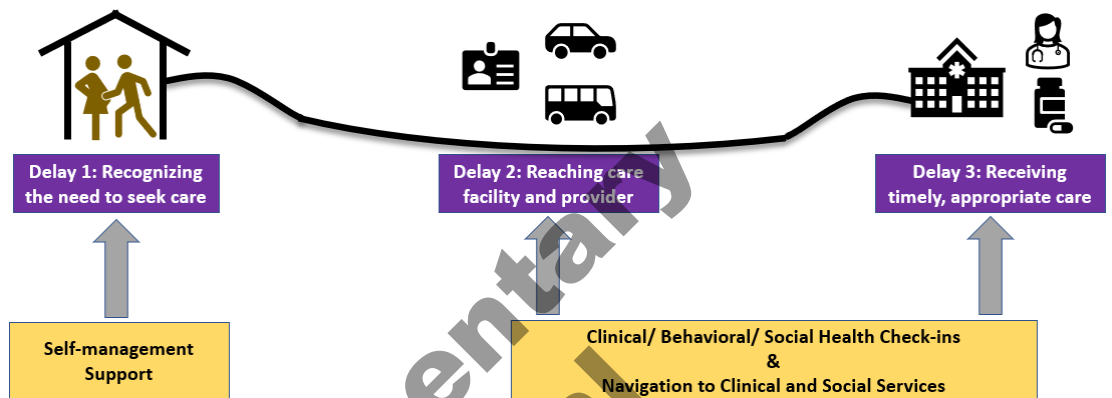

Figure 2. Three Delays Model with MOMs Program Intervention Components

The specific intervention components across both study arms include clinical check-in/consistent monitoring, navigation to care and social services, and self-management support. Each intervention component is supported by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists Guidelines for Perinatal Care.[69] Self-management support addresses the phase 1 delay by increasing birthing peoples' maternal health knowledge and awareness of signs and symptoms for potential emergencies. Also, self-management support will be tailored to the needs and risks of the individual birthing person to increase engagement in health behaviors (i.e., self-monitoring, physical activity, healthy eating, medication adherence, and stress management) that promote self-management of chronic conditions. The clinical check-in/ consistent monitoring and navigation intervention components are designed to address phases 2 and 3 delays. With the consistent monitoring of high-risk Black birthing people, potential emergencies can be identified, documented, and addressed earlier. Based on reported symptoms and risks, birthing people are successfully connected to the appropriate healthcare provider (e.g., obstetrics, cardiology, behavioral health) or emergency care services to receive timely and appropriate care. Navigation also involves addressing social risks (e.g., poor access to care due to lack of transportation or medical coverage; food insecurity; housing instability) that may be a barrier to accessing appropriate healthcare in a timely manner.[10] Together, self-management support enhances the knowledge and confidence of birthing people to take health-promoting actions that decrease risk, to monitor and detect when something is wrong, and to share their concerns during clinical check-ins; while navigation is critical to close the loop and address potential or actual clinical and behavioral health emergencies as well as social needs to further reduce risk for SMM.

	Months																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
									Delivery												
	Prenatal									Postpartum											
Arm 1 – MOMs High Touch																					
OB-Chat																					
Prenatal Telehealth Visits (12 total)																					
Postpartum Telehealth Visits (4 total)																					
Arm 2 – MOMs Light Touch																					
OB-Chat																					
Postpartum Telehealth Visits (4 total)																					

Figure 3: Timing of Intervention Components by Study Arm

Study Arms (Figure 3)
MOMs High Touch (MOMs-HT)
OB-Chat. At the end of the enrollment and randomization call, the research assistant will assist the participant in enrolling in OB-Chat, a personalized care digital conversation chatbot. From that point the participant will receive weekly "chats" from OB-Chat via text message or email. Each chat begins with, "How are you feeling today?" If the birthing person responds with any clinical or behavioral health concerns, enters an elevated blood pressure value, and/or reports a social need (i.e., housing instability, food insecurity, lack of transportation, low level of support, interpersonal violence) the chatbot is designed to escalate this concern to the 24/7 nurse led call center within the MOMs Program. A nurse from the call center will then follow-up via phone call within one day for moderate concerns (e.g., lack of transportation to obstetrics appointment) or immediately for severe concerns (e.g., feeling unsafe at home) and connect the birthing person to clinical or social services. Birthing people can also initiate a chat on their own outside of the scheduled weekly chat to request assistance with scheduling appointments or to report any concerns, which will be escalated to the MOMs team. In addition to facilitating clinical check-ins/monitoring and escalating alerts for navigation, OB-Chat provides timely educational tools and resources to promote a healthy pregnancy and birth including encouragement to engage in physical activity daily and eat a healthy diet; personalized birthing phase recommendations; information about what to expect each week during the birthing continuum and at appointments; and the ability to track blood pressure (see Figure 4). OB-Chat will be available to participants from the time of enrollment to 1-year postpartum and is available in both English and Spanish. *Note that study enrollment may occur at any time up to 12 weeks gestational age based on clinical eligibility criteria*.
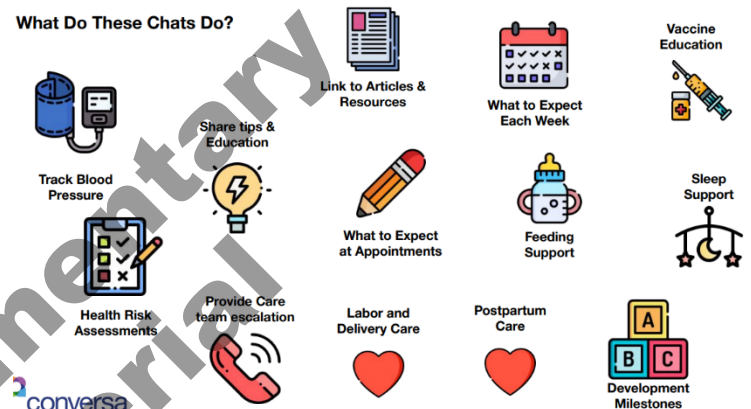
Figure 4. OB-Chat Resources

Prenatal Telehealth Visits. In addition to OB-Chat, following the enrollment call, the participant will be assigned a MOMs CMC or a RN (for birthing people with severe high risk such as diabetes with insulin treatment) who will deliver 12 bi-weekly telehealth visits via videoconferencing or phone, depending on the participant's preference, during the prenatal period. The first telehealth visit will be 30-45 minutes in duration and follow-up visits will be 15-20 minutes. These telehealth visits will involve a clinical and behavioral health check-in, navigation to clinical or social services as needed, screening for social needs during the initial telehealth visit (i.e., housing stability, utilities, food access, transportation access, interpersonal safety), follow-up on referrals to resources to address social needs, and self-management support. Clinical check-ins will consist of asking the participant if they have experienced any signs or symptoms of concern since the last check-in (e.g., pain, discomfort, headaches, bleeding), screening for depression and anxiety, and reminders about upcoming medical appointments. Based on responses during the clinical check-in, the CMC or RN will navigate the birthing person to the appropriate provider (e.g., OB, cardiologist, behavioral health) or services (e.g., emergency, social, community-based resources) in a timely manner. The MOMs team has established workflows and protocols to navigate birthing people effectively and efficiently to cardiologists and behavioral health. Navigation services, including referrals, will be documented in the EHR to facilitate awareness and collaborative care amongst the birthing person's care team.

Also, during the telehealth visits, CMCs or RNs will provide tailored self-management support. They will assess progress with engagement in self-management behaviors since their last visit, including asking about minutes and type of physical activity, self-monitoring (blood pressure, blood sugar, weight), and taking medications. CMCs and RNs will facilitate goal setting and problem solving with participants to set realistic physical activity

and other behavioral goals and identify and address barriers (including social needs) to engaging in behavior change. For example, participants may indicate that living in an unsafe neighborhood prevents them from staying active. CMCs will work closely with the participant to come up with alternative activities that can be done inside the home or at publicly accessible and safe community centers.

Postpartum Telehealth Visits. A CMC or RN will conduct a clinical check-in (with navigation as needed) by phone 24 and 72 hours after labor and delivery. After the 72-hour call, clinical check-ins with navigation will occur weekly via phone or videoconferencing until 4 weeks postpartum. During the postpartum period, birthing people may be navigated to clinical services such as cardiology, behavioral health, or lactation services as well as connected to social services such as WIC or SNAP to address household food insecurity. Telehealth visits during the postpartum period will be 15-20 minutes in duration. CMCs or RNs may provide some self-management support as needed, but the primary focus of these visits will be to assess for clinical, behavioral health, and social need concerns. As feasible, birthing people will work with the same CMC or RN throughout the intervention period to establish trust and promote relationship building.

MOMs Low Touch (MOMs-LT)
OB-Chat. Participants randomized to MOMs-LT will be setup with OB-Chat during the study randomization/enrollment call. MOMs-LT participants will also have access to OB-Chat from the time of enrollment during the prenatal period to 1-year postpartum. Similar to MOMs-HT, clinical, behavioral health, and social need alerts identified via weekly OB-Chats will be routed to the 24/7 nurse-led call center within the MOMs Program.

Postpartum Telehealth Visits. Close to delivery, a CMC or RN will be assigned to participants enrolled in MOMs-LT to conduct clinical check-in calls 24 and 72 hours after labor and delivery. The CMC or RN will continue with 4 weekly clinical check-ins via phone or videoconferencing during the first month postpartum. Navigation to clinical, behavioral health, and social services will be provided as needs are identified. In this arm CMCs and RNs will not provide intensive self-management support, but may remind participants about upcoming appointments, blood pressure monitoring, and taking medications.

Intervention Training and Fidelity
Newly hired CMCs and RNs will undergo one month of onboarding and training in transitional care management and motivational interviewing that will be led by MOMs Program Manager and Ms. Galapo-Goldstein (MOMs Program Supervisor). The PI (Fitzpatrick) and Co-I (Hill-Briggs) will conduct a 1-week training for all CMCs, RNs, and the MOMs Program Supervisor on behavior change principles, chronic disease self-management, and self-management support. Booster trainings will be offered annually. Ms. Galapo-Goldstein will meet with the CMCs and RNs bi-weekly for group supervision/ case management. Ms. Galapo-Goldstein will meet with the PI for monthly supervision. Clinical check-ins and navigation will be tracked in the electronic platform, Care Tool, which is currently utilized by the MOMs team.

In partnership with Mama Glow, CMCs will also receive doula training. Mama Glow is a Black woman-owned, New York-based nonprofit that trains doulas and offers doula support throughout the birthing continuum. To date, over 4000 people from around the world have participated in their globally recognized doula immersion program. In Year 1 of this study, CMCs will receive the Mama Glow Doula Homeschool Level 1 Professional Training Program. This is a 6-week intensive training program covering pregnancy through the early postpartum period. Classes will be weekly, 3.5 hours in duration, delivered via Zoom, and led by the founder of Mama Glow, Latham Thomas. The program includes live digital training modules on pregnancy, childbirth, and postpartum care (including breastfeeding, newborn care, and recovery from childbirth) and assignments that CMCs can complete on their own time. CMCs will have access to a private online community with other individuals in the New York area completing the training as well as a designated teacher assistant for support during the program. The training program is designed to provide participants with knowledge and skills they need to support expectant mothers, birthing people, and their families throughout the childbirth process. In addition to the core curriculum, the program includes workshops and classes on various topics such as communication skills and self-care. Upon completion of the Level 1 doula training program, CMCs will receive a Mama Glow Doula Trainee Certificate and will be on the path towards doula certification, if they decide to pursue doula certification. By providing CMCs with this additional specialized training, they will acquire

knowledge and skills in maternal health support that will have positive implications for participant retention, staff retention, and sustainability of the MOMs Program.

Study Outcomes and Data Collection

The hypothesized pathways for the effect of MOMs-HT vs. MOMs-LT on primary and secondary outcomes are displayed in Figure 5.

Prevalence of SMM (primary). According to the CDC, SMM (yes or no) is defined as having ≥ 1 ICD-10 diagnosis codes that correspond to the 21 SMM indicators.[4] This is the current practice used by healthcare systems in the US and will allow

Figure 5. MOMs Hypothesized Pathways for SMM Reduction

for comparison to state and national prevalence. Using the Northwell Health Perinatal Data Center, we will capture SMM indicator diagnoses at labor and delivery, from delivery to 1-month postpartum during a hospital admission, and from delivery to 1-year postpartum during a hospital admission. Similar to previous studies,[4,5] we will examine SMM incidence both including and excluding blood transfusions.

Preeclampsia (secondary). We will use the Northwell Perinatal Data Center to also capture any preeclampsia diagnosis from study enrollment to labor and delivery (i.e., during the prenatal period) in both study arms. The following ICD-10 codes will be used to determine preeclampsia diagnosis: O14.1, O14.10, O14.12, O14.13, O14.14, or O14.15.

Perceived Social Support (secondary). We will examine three domains of social support – informational, emotional, and tangible. Informational support is having someone that can provide facts and advice while helping to enhance one's knowledge about a particular topic or issue. Emotional support is feeling like there is someone who cares and expresses concern and empathy. Tangible support is having someone who can provide or help navigate a person to needed services and goods. We will administer the 10-item Informational Support and the 12-item Emotional Support scales from the Patient Reported Outcomes Measurement Information System (PROMIS) to all patients over the phone at baseline, and via emailed REDCap link at 1-month and 1-year postpartum. Both measures are on a 5-point Likert scale (ranging from 'never' to 'always') and have been found to be valid and reliable measures of informational and emotional support in both English and Spanish.[70] We will collect patient ratings of tangible support on 8 items derived from the focus groups with previous MOMs participants. Tangible support ratings will assess the degree to which patients feel supported in accessing clinical care, medications, social services, and other resources to address barriers to care and self-management.

Physical Activity (exploratory). We will examine physical activity using both self-report measures and data from a wearable activity monitor. The short-form International Physical Activity Questionnaire (IPAQ)[71] will be administered via emailed REDCap link at baseline, 1-month and 1-year postpartum to examine self-reported physical activity. Participants in each study arm will also be mailed a Fitbit Charge 5 along with instructions on setup and placement within one week after study enrollment. They will be asked to wear the Fitbit during the entire study period and all data will be stored on Fitabase, a secure web-based platform that aggregates data from Fitbit devices. Participant barriers to participating in exercise (14-item Barriers to Exercise Scale[72]) and their motivation to exercise (24-item Behavioral Regulation in Exercise Questionnaire[73]) will also be assessed via emailed REDCap link at baseline, 1-month and 1-year postpartum.

Process Measures. We will extract process measure data from OB-Chat, the Care Tool platform (used by the MOMs team), and the Northwell Health EHR and Perinatal Data Center.
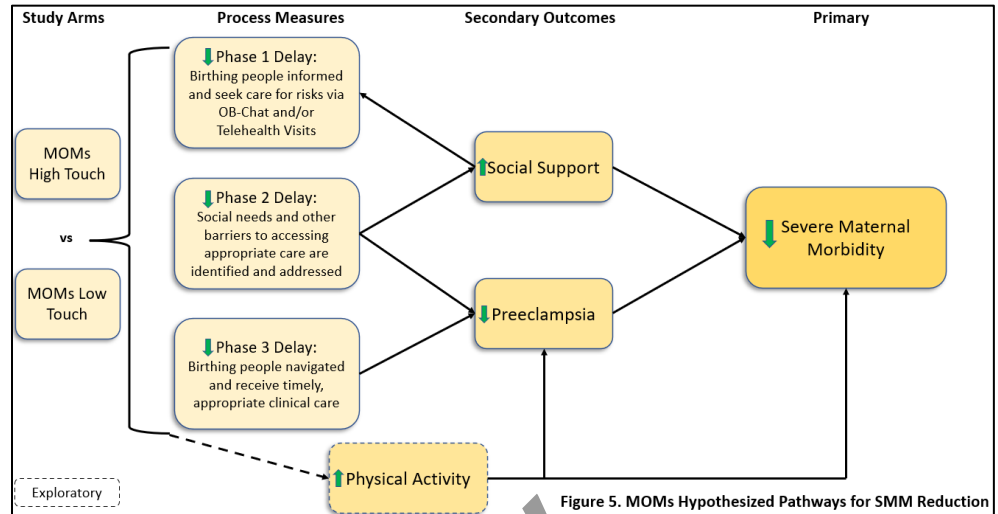
- *Social risk and needs data:* A social needs screener that assesses transportation, food access, level of support, housing stability, and interpersonal safety will be administered via OB-Chat upon enrollment, at 14- and 28-weeks gestational age, and at 3-days and 5-weeks postpartum. Responses to this social need screener via OB-Chat will be extracted. Furthermore, social needs identified and referrals to social services and/or community-based resources and the outcome of those referrals will be documented by the CMCs in the Care Tool platform and extracted.
- *OB-Chat usage data:* We will extract usage data from OB-Chat including responses to weekly chats, blood pressure values entered, and viewing of educational tools and resources.
- *Tracking maternal health risks and navigation efforts:* Clinical, behavioral health, and social need alerts routed to the MOMs team will be captured via OB-Chat and documentation in the Care Tool platform. Diagnosis codes associated with hypertensive disorders or other complications in pregnancy will also be captured using the EHR and Perinatal Data Center. Any documentation or encounter codes indicating alert status and/or resolution in Care Tool or the EHR will also be extracted.
- *Maternal healthcare utilization:* We will use the EHR and Perinatal Data Center to extract any maternal health-related clinical encounter data (outpatient, inpatient, emergency department visits), and missed appointments.

Analysis Plan

All analyses will be carried out according to the intent-to-treat principle (ITT), i.e., participant data will be analyzed according to the assigned intervention arm. The level of missing data will be ascertained for each outcome of interest. Data may be missing due to patient dropout or nonresponse. Birthing people who do not have a successful birth will still be included in sensitivity analysis and miscarriages will be treated as adverse events. Before we carry out analyses, we will audit the data for quality and completeness. We will examine variable distributions for outliers and assess them to ensure that they meet the assumptions of the planned analysis. Baseline characteristics will be compared among those with and without missing data. For missing data, we will use multivariate imputation by chained equation (MICE). Depending on the amount of missing data we will perform sensitivity analyses of different multiple imputation (MI) strategies including MI-predictive mean matching (PMM) and log MI-PMM.[74] Sensitivity analyses will be performed to compare results from complete case analysis and MI to assess if imputation induced any bias. All analyses will be performed at 0.05 significance level and completed with R statistical software, version 4.3.0 (R Core Team, 2023).

Aim 1 – Compare MOMs-HT to MOMs-LT on the incidence of SMM at labor and delivery.

For Aim 1, we will provide point estimates and 95% confidence intervals (CIs) for the incidence of SMM at labor and delivery in each study arm: MOMs-HT and MOMs-LT. To estimate the cumulative unadjusted incidence risk ratio (RR) for the association between study arms (MOMs-LT as the reference arm) and our primary outcome, SMM (yes/no), we will employ a log-binomial regression model with maximum likelihood estimation. The same methodology will be used to estimate the adjusted RR in a multivariable model, adjusting for potential confounders including gestational age at enrollment, OB-CMI score, type of medical coverage, BMI, urban vs. rural residential area, and neighborhood level education and household income. We will report the RRs and 95% CIs. Analyses will be conducted separately for SMM including and excluding transfusions. As an exploratory analysis, we will compare the frequencies of the 21 SMM-defining conditions between the two arms. No formal statistical test will be used at this step, and we will use standardized differences to evaluate the comparability of each SMM comorbidity indicator. Unlike p-values, standardized differences are independent of sample size and represent a measure of the mean difference for a given covariate between two groups. We will report the standardized differences as absolute values.

Power calculations. A previous maternal health study focused on providing timely blood pressure treatment during the prenatal period[25] and preliminary findings from the MOMs Program among Black birthing people[60] demonstrated a 72% and 77% reduction in risk for SMM, respectively. Given the SMM prevalence of 6.2% among Black birthing people at Northwell Health, an estimated difference of at least 4.5% absolute reduction in the prevalence of SMM[25,60,75] at labor and delivery for MOMs-HT compared to MOMs-LT, and a two-tailed alpha level of .05, we will have at least 80% power using a two-sided z-test, unpooled variance with a minimum of 293 participants per arm (N = 586). We plan on recruiting 352 participants per arm (N = 674) to allow for up to 15% attrition, a conservative estimated based on MOMs preliminary data.[60]

<u>Aim 1a – Compare study arms on the incidence rate of SMM-related hospital admissions at 1-month and 1-year postpartum.</u>
For each study arm, we will report the point estimates and 95% CIs for the rates of SMM-related hospital admissions at 1-month and 1-year. Next, separate (1-month and 1-year) uni- and multivariable log-binomial regression models will be employed to estimate the RRs between the arms, with and without adjustment for the covariates included in Aim 1 analysis. Among birthing people with multiple hospital admissions, we will consider the first occurrence in our outcome measures.

<u>Aim 2 – Compare study arms on rate of preeclampsia.</u>
For Aim 2, we will report the point estimates and 95% CIs of the preeclampsia rates for each of the study arms. Log-binomial regression models will be employed to test the association between study arms and preeclampsia rates between study enrollment and labor and delivery in univariable analysis and also adjusted for the same covariates used in Aim 1 analysis.

<u>Aim 3 – Examine the effect of study arms on change in perceived social support domains.</u>
Changes from enrollment to 1-month and enrollment to 1-year postpartum in the total scores of emotional support, informational support, and tangible support (assessed separately) will be summarized using descriptive statistics (mean ± SD and/or median ± interquartile range) for each study arm. The effect of MOMs-HT compared to MOMs-LT (binary indicator) on score changes for each of these domains will be assessed using linear regression analyses both in univariable and multivariable (adjusting for the same covariates included in Aim 1 analysis) models. If the normality assumption is violated, we will apply a log-transformation of the outcome. Unadjusted and adjusted regression coefficient estimates, and their corresponding 95% CIs will be reported.

<u>Aim 4 – Explore the effect of each study arm on patterns of engagement in physical activity and subsequent association with maternal health outcomes.</u>
We will record the total number of minutes of physical activity per week. Participants' trajectories and longitudinal changes (from enrollment to labor and delivery and from enrollment to 1 year postpartum) will be summarized monthly and reported numerically and graphically. Changes over time between the two study arms will be assessed using linear mixed models. To account for the repeated observations nested within an individual, the models will include individual-level random intercepts. The main fixed effects will include study arm, time, and similar covariates included in Aim 1 analysis. To determine whether changes in physical activity over time are affected by the study arm, we will also examine the interaction term between time and study arm. If the normality assumption is not satisfied, we will apply a log-transformation of the outcome. We will ascertain the level of missing data each month. The mixed models provide some flexibility in assuming data missing at random, but we still will investigate patterns of missingness, including MICE. Depending on the amount of missing data, we will perform sensitivity analyses of different MI strategies, including MI-PMM and log MI-PMM. We will compare the results to those obtained from complete case analysis.

To examine the association between patterns of physical activity and maternal health outcomes, we will apply latent class growth model (LCGM) analysis. Latent class growth models (LCGM) will be used to determine potential subgroup classifications as a function of different trajectories of change in physical activity. The optimum number of trajectories yielding the most parsimonious model that has both a good fit and clinical relevance will be chosen using three criteria: the sample size-adjusted Bayesian information criterion (BIC, smaller=better), the root mean square error (RMSE, ~0.01 indicates excellent model fit), and the model entropy (quantifies classification error). The models will be specified by two latent parameters: a random intercept and a random slope; the growth functions will be captured using linear, quadratic, and/or piecewise terms. The variance around growth parameters will be estimated with latent classes and allowed to vary freely across classes. Observed individual trajectories and estimated mean trajectories will be plotted for each class.

We will determine if gestational age at enrollment, OB-CMI score, type of medical coverage, BMI, urban vs. rural residential area, and neighborhood level education and household income predict trajectory membership using logistic regression, reporting results as odds ratios and 95% CIs. Then, we will employ log-binomial regression models, with study arm as a binary predictor of the physical activity classes, to test if the classes are predictors of: 1) preeclampsia rates (enrollment to labor/delivery) and 2) SMM-related hospital admissions (enrollment to 1-year postpartum), adjusting for covariates mentioned above.

Potential Challenges and Strengths

First, we acknowledge the potential difficulties with recruiting early during pregnancy and retaining a large sample of high-risk Black birthing people.[76] To overcome these potential challenges, we will utilize our sophisticated data systems (i.e., Northwell Perinatal Data Center) to identify potentially eligible patients upon first prenatal encounter as well as use the targeted phone-based recruitment approach that is currently used by the MOMs Program, which has successfully enrolled 3500 high-risk birthing people (~25% Black/African American) to date at Northwell. Furthermore, we will leverage the community-engagement initiatives of the Northwell Center for Maternal Health, which involves engaging Black birthing people throughout the birthing continuum, including pre-pregnancy, via maternal health community events, online resources and educational videos, and partnerships with maternal health-focused community organizations to support recruitment and retention efforts as needed.

Although participants will receive weekly pings from OB-Chat throughout the study period, participants randomized to MOMs-LT may have limited engagement with OB-Chat, especially if they do not experience any emergencies or concerns that need to be addressed by the MOMs team during the prenatal period. To address this potential challenge, participants in both study arms will receive monthly emails and/or text messages reminding them to check and review resources available on OB-Chat. Similarly, participants in both study arms will receive monthly reminder emails and/or text messages to wear the Fitbit daily. Even though the Fitbit could be considered a low-touch intervention on its own via self-monitoring and feedback, we do not anticipate an effect of the Fitbit since both study arms will have access. Lastly, relying primarily on the EHR for our primary (SMM) and some secondary outcomes (preeclampsia), there is a potential risk for missing data. However, Northwell is part of the Healthix public health information exchange in New York, which facilitates sharing of some health record data elements across health care systems. Thus, even if participants decide or need to give birth or seek care outside of a Northwell Health facility, we will still be able to capture the encounter(s), diagnoses, procedures, and care plans.

Despite these potential challenges, there are several strengths in this application that represent rigor, but also pragmatism in the study design and implementation plan that will help to ensure sustainability including:
- Randomized clinical trial design
- Use of existing infrastructure, technology, data systems, workflows, and clinical and non-clinical staff
- Multidisciplinary research team
- Partnership with community-based organization (i.e., Mama Glow) to enhance intervention training and support
- Systematic screening and documentation of social needs as well as referrals to social services and community-based resources

Given the expertise of the research team, longitudinal study design, and Northwell's commitment to promoting Black maternal health equity, we are well-positioned to successfully complete this study and contribute to advancing integrated maternal care models to improve maternal health outcomes among Black birthing people.

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R01NR021134 RESPONSE TO REVIEWERS

We appreciate the reviewers' enthusiasm for this "very important" project that will "have a high overall impact on the field of maternal health," noting numerous strengths including "high significance," "highly successful investigative team," "innovative use of technology," "multi-faceted integrated care model," and "potential generalizability of the findings." Responses to their concerns are below.

Will there be a difference between study arms on outcomes? In the pilot of the original MOMs program (Brown et al. *AJOG*. 2023;229(2)), the intervention was only delivered during the 4 weeks postpartum period immediately following delivery and demonstrated effectiveness at 30-days postpartum. MOMs-LT and MOMs-HT are designed to test the effect of different levels of support starting during the prenatal period and continuing through 1-year postpartum. MOMs-LT is an ideal comparison arm as it allows us to examine the effect of a primarily remote, less resource intensive intervention that involves bi-directional conversation (i.e., education and support), tracking blood pressure (BP) measurements, and triaging for alert values and emergencies via a chatbot throughout the birthing continuum. To further distinguish the two arms, participants randomized to the MOMs-HT arm will also receive a BP monitor along with education and support from the MOMs interventionist on home BP monitoring. Home BP monitoring has been shown to be effective in identifying hypertensive disorders in pregnancy and initiating treatment earlier (Yeh et al. *BMC Pregnancy Childbirth*;22(1)). Thus, the proposed study design allows us to examine the effect of support via chatbot + monitoring and support for emergencies + home BP monitoring + 12 bi-weekly behavioral counseling sessions (MOMs-HT) vs. MOMs-LT delivered during the prenatal period on severe maternal morbidity (SMM) at labor and delivery (primary outcome). Both study arms will include the 4-weekly check-ins postpartum and will be compared on SMM at 30-days postpartum and 1-year postpartum (secondary outcomes).

What are the demographics of the targeted population? Approximately 40% of the participants in the MOMs pilot study were covered by Medicaid, suggesting that the original MOMs program was effective for reducing SMM-related hospitalizations among Black and low-income birthing people. We expect a similar proportion of Medicaid recipients to be enrolled in this proposed study. In addition to a social risk screener, education will be assessed at baseline and the social vulnerability index will be calculated for each participant. We will conduct subgroup analysis based on medical coverage and other SES factors.

At what gestational age will participants be enrolled? We have revised our inclusion criteria to allow recruitment and enrollment into the study by no later than 16 weeks gestational age. This will help to enhance inclusion of birthing people for whom prenatal care is delayed due to socioeconomic or other factors.

How will the effect of the intervention on preeclampsia be assessed? We have revised our Aim 2 – Compare the two study arms on time to documented preeclampsia diagnosis and initiation of treatment. We will use the electronic health record to extract this information and conduct time to event analysis.

How will the implementation of the MOMs intervention be examined? We have added an Aim 5 – examine implementation determinants and outcomes using a mixed methods approach – that is informed by both the RE-AIM and Health Equity Implementation Frameworks and will include assessing intervention acceptability, fidelity, appropriateness, penetration, and sustainability/maintenance. Dr. Stephanie Fitzpatrick (PI) has expertise in implementation science (R01DK115237; R34DK119853) and was a fellow in the NCI-funded Mentored Training in D&I Research. For additional expertise in mixed methods, we have added Dr. Melissa Basile, Assistant Professor at Northwell Health, as a Co-I.

Will community partners, clinicians, and patients be engaged? The Steering Committee will meet every other month and will consist of Northwell Health clinicians as well as leadership of the Northwell Center for Maternal Health who will provide input on study design and implementation. We will also form a community advisory board (CAB) with representatives from our partnering organizations (Mama Glow, Birth Justice Warriors, Black Coalition for Safe Motherhood, and Health Equity at Nassau County Dept. of Health) and 2 patient partners. The CAB will meet quarterly and provide input on areas such as recruitment and retention strategies, intervention sustainability, and policy impact.

What is the role of physical activity assessment in this study? Participants in both study arms will receive a Fitbit to track their physical activity, which will provide novel data about patterns of engagement in physical activity throughout the birthing continuum. In addition, participants will complete questionnaires to better understand the type of activity and motivation and barriers to engaging in physical activity. Participants will receive instructions and support on using the Fitbit at enrollment; those who have not worn or synced their Fitbit in the past 2 weeks will receive a reminder via email and/or text.

DATA MANAGEMENT AND SHARING (DMS) PLAN

Data Type

A. Types and amount of scientific data expected to be generated in the project: Summarize the types and estimated amount of scientific data expected to be generated in the project.

This study will collect clinical, psychosocial, and physical activity data from 674 individuals utilizing validated tools, electronic health records, and wearable device. Data collection tools, frequency of collection and type of data are listed below:

Type	Data Collection Tool	Time Frame/Amount	Brief Description
Objective Data: Severe Maternal Morbidity (SMM) Indicators	ICD-10 diagnosis codes of 21 indicators of SMM entered into the Northwell Health electronic health record during hospital admission	Labor and delivery; from labor and delivery to 1-month postpartum; from labor and delivery to 1-year postpartum	The Centers for Disease Control & Prevention defines SMM as having ≥ 1 ICD-10 diagnosis codes that correspond to the 21 SMM indicators. We will capture ICD-10 codes for each indicator per participant if they occur as well as a binary variable indicating 'yes or no' for SMM at the specified timepoints.
Objective Data: Preeclampsia	ICD-10 diagnosis codes associated with preeclampsia entered into the electronic health record	Will capture the incidence of preeclampsia throughout the prenatal period	ICD-10 codes associated with diagnosis of preeclampsia during the prenatal period will be extracted from the electronic health record and there will be a binary variable (preeclampsia 'yes or no') for each participant. We will also capture any history of preeclampsia during previous pregnancies as this will be used as one component to determine study eligibility.
Self-Report Data: Informational Support	PROMIS 10-item Informational Support measure	Administered at baseline, 1-month and 1-year postpartum	Validated questionnaire available in English and Spanish assessing patient's perceived support in terms of having someone that can provide facts and advice while helping to enhance their knowledge about a particular topic or issue. Data will be stored in REDCap, a secure online survey tool.
Self-report Data: Emotional Support	PROMIS 12-item Emotional Support measure	Administered at baseline, 1-month and 1-year postpartum	Validated questionnaire available in English and Spanish assessing patient's perceived support in terms of feeling like there is someone who cares and expresses concern and empathy. Data will be stored in REDCap, a secure online survey tool.
Self-Report Data: Tangible Support	8-item Tangible Support measure	Administered at baseline, 1-month and 1-year postpartum	Newly developed questionnaire assessing patient's perceived support in terms of having someone who can provide or help navigate a person to needed services and goods. Data will be stored in REDCap, a secure online survey tool.

Self-Report Data: International Physical Activity Questionnaire (IPAQ)	7-item International Physical Activity Questionnaire (IPAQ)	Administered at baseline, 1-month and 1-year postpartum	7-item validated questionnaire to measure frequency and duration of moderate and vigorous physical activity, walking, and sitting. Data will be stored in REDCap, a secure online survey tool.
Self-Report Data: Barriers to Exercise Scale	14-item Barriers to Exercise Scale	Administered at baseline, 1-month and 1-year postpartum	14-item validated questionnaire to measure barriers to exercise. Data will be stored in REDCap, a secure online survey tool.
Self-Report Data: Behavioral Regulation in Exercise Questionnaire	24-item Behavioral Regulation in Exercise Questionnaire	Administered at baseline, 1-month and 1-year postpartum	24-item validated questionnaire to measure participant's motivation to exercise. Data will be stored in REDCap, a secure online survey tool.
Objective Data: Wearable physical activity monitor	Fitbit	Continuously from study enrollment to 1-year postpartum	Participants will be asked to wear a Fitbit daily from the time of study enrollment to 1-year postpartum to capture (at a minimum) frequency, intensity, and minutes of physical activity bouts.
Obstetrics Comorbidities	Obstetrics Comorbidity Index (OB-CMI)	Baseline One measurement	This validated, weighted index takes into account the number and severity of possible comorbid conditions/ maternal health factors associated with increased risk for severe maternal morbidity. Data will be captured from the electronic health record and stored in REDCap as it will be used as study inclusion criteria.
Sociodemographics	Extracted from electronic health record and confirmed during study enrollment	Baseline One measurement	Patient race, ethnicity, age, sex, gender, and preferred language will be extracted from the electronic health record and confirmed during the study enrollment call. Neighborhood-level household income and educational attainment will be determined using patient addresses and publicly available Census data. Data will be stored in REDCap.

B. Scientific data that will be preserved and shared, and the rationale for doing so: Describe which scientific data from the project will be preserved and shared and provide the rationale for this decision.

Participant data related to the primary and secondary outcomes will be shared with scientists on the Open Science Framework (OSF) repository. This will include the 21 severe maternal morbidity indicators,

preeclampsia diagnosis, and responses to the perceived social support domain measures. We will also include data relating to exploratory analyses (physical activity questionnaires; Fitbit data summarizing frequency, intensity, and minutes of physical activity bouts), including data for variables which may moderate the primary analyses (e.g., sociodemographics, comorbidity). The goal of all shared data will be to facilitate replication of all primary and secondary, and exploratory study analyses as well as to allow for additional analyses with available data. Data will be redacted to strip all individual identifiers, and effective strategies should be adopted to minimize risk of disclosing a participant's identity. Whenever possible, raw participant-level data will be shared along with documentation of how variables were cleaned, coded, or summarized. In cases where participant-level data could be used to identify individuals, summary data will be presented rather than raw data. Information about how summary data was generated will be provided in the data dictionary.

C. Metadata, other relevant data, and associated documentation: Briefly list the metadata, other relevant data, and any associated documentation (e.g., study protocols and data collection instruments) that will be made accessible to facilitate interpretation of the scientific data.

A copy of the study protocol, informed consent form, manual of operations and assessment tools will also be posted on Open Science to facilitate interpretation of the scientific data. This will include descriptions of the variables measured, interpretations of the variables, information about variable coding, and information regarding standardized measures. In addition, data analysis code will be posted from the statistical software utilized in the primary analyses (SAS or R) to allow for replication of study analyses. All analysis code will be annotated and/or presented with comments to allow for easier replication of study findings.

Related Tools, Software and/or Code
State whether specialized tools, software, and/or code are needed to access or manipulate shared scientific data, and if so, provide the name(s) of the needed tool(s) and software and specify how they can be accessed.

No special tools will be needed to access shared scientific data from this project. Raw and summarized data will be provided in readily accessible formats (e.g. ".csv") which can be utilized by most data management or analysis software programs. It is possible that particular data visualizations presented in dissemination activities (e.g. publications, presentations, posters, etc.) may be linked to specific software. For example, a figure visualizing an outcome may be generated using a particular package in the statistical software R. In these cases, descriptions of how figures were generated will be included and citations will be made to the software/methods used.

Standards
State what common data standards will be applied to the scientific data and associated metadata to enable interoperability of datasets and resources and provide the name(s) of the data standards that will be applied and describe how these data standards will be applied to the scientific data generated by the research proposed in this project. If applicable, indicate that no consensus standards exist.

All data will be coded and without any personal health information, individual identifying information, and any data elements which may include HIPAA identifiers. This may lead to displaying summary data (e.g., a categorical age variable rather than a continuous age). In cases where data is presented in a summarized format, the coding of these variables will be clearly defined in the associated data dictionary. For previously existing measures (e.g., severe maternal morbidity, PROMIS social support questionnaires), data will be stored and scaled scores will be

developed using traditional coding methods previously applied in scientific literature and/or clinical practice. A data dictionary will be provided clearly identifying how individual variables are coded (e.g., how response options correspond to numeric scores) and evaluated (e.g., indicating that higher scores correspond to higher levels of the measured construct). The data dictionary will provide the necessary context for interpretation of the raw and summary data. In addition to the data dictionary, all publications will include clear descriptions and citations for each measure used.

Data Preservation, Access, and Associated Timelines

A. Repository where scientific data and metadata will be archived: Provide the name of the repository(ies) where scientific data and metadata arising from the project will be archived; see Selecting a Data Repository).

Study data and metadata will be stored on the Open Science Framework (OSF) platform and available in advance of the first publication of study outcomes or the end of the award period, whichever comes first. De-identified data will be stored on OSF indefinitely to allow for continued access.

B. How scientific data will be findable and identifiable: Describe how the scientific data will be findable and identifiable, i.e., via a persistent unique identifier or other standard indexing tools.

The URLs for all projects, components, and files on OSF are GUIDs. Any inclusion of URLs in published manuscripts will enable readers to find the particular files referenced. Additionally, a citation is automatically generated for each project and component on OSF. This citation can be included in the reference sections of articles citing the files, so that all contributors who shared data, code, and materials are properly credited when those files are reused. All dissemination activities (including publications, presentations, posters, etc.) will include references and the URL address for the OSF platform where data is stored to ensure easy access.

C. When and how long the scientific data will be made available: Describe when the scientific data will be made available to other users (i.e., no later than time of an associated publication or end of the performance period, whichever comes first) and for how long data will be available.

As stated above, study data and metadata will be stored on the Open Science Framework (OSF) platform and available in advance of the first publication of study outcomes or the end of the award period, whichever comes first. De-identified data will be stored on OSF indefinitely to allow for continued access.

Access, Distribution, or Reuse Considerations

A. Factors affecting subsequent access, distribution, or reuse of scientific data: NIH expects that in drafting Plans, researchers maximize the appropriate sharing of scientific data. Describe and justify any applicable factors or data use limitations affecting subsequent access, distribution, or reuse of scientific data related to informed consent, privacy and confidentiality protections, and any other considerations that may limit the extent of data sharing. See Frequently Asked Questions for examples of justifiable reasons for limiting sharing of data.

To comply with de-identification guidelines, some variables may be omitted or presented in summary format in the data posted on Open Science Framework. The goal for removing this information is to prevent disclosure of personal health information (PHI) or identifiable information. For individuals who wish to have access to the full

dataset (including information which may identify individual participants), a request for data can be made to the study principal investigator (in this case Dr. Fitzpatrick) and to the regulatory team for the Institute of Health System Science (IHSS) at Northwell Health. Data requests will be reviewed by the regulatory team and access to full data will be granted following Northwell Health Institutional Review Board (IRB) approval, as applicable, and completion of a data use and sharing agreement with Northwell Health. Details about the process for requesting additional data and contact information for both the study PI and the IHSS regulatory team will be clearly detailed in the OSF posting. This will include contact information for the PI and members of the regulatory team as well as directions for making data requests.

B. Whether access to scientific data will be controlled: State whether access to the scientific data will be controlled (i.e., made available by a data repository only after approval).

De-identified study data will be made freely available to all interested individuals via the posting to OSF. Access to data which may contain PHI or individually identifiable information will require a formal data request and approval from the Northwell Health IRB as detailed above.

C. Protections for privacy, rights, and confidentiality of human research participants: If generating scientific data derived from humans, describe how the privacy, rights, and confidentiality of human research participants will be protected (e.g., through de-identification, Certificates of Confidentiality, and other protective measures).

Data collected in this study will only be collected from participants who meet initial study eligibility criteria following screening, and who participate fully in the informed consent process. This includes listening and asking questions during the reading of the Northwell IRB consent document by a research assistant over the phone, containing all of the elements of informed consent required by 45 CFR 46.116 and elements of authorization required by the HIPAA Privacy Rule, and the provision of verbal consent. Participants will be able to request that a copy of the consent document be emailed or mailed to them for future reference. The consent document will notify participants that data collected and generated from this funded project will be made available for future research so that individuals are fully informed of this data sharing practice. Additionally, direct communication with research personnel via encrypted email, text message, phone or video call is available. Research assistants will be available to answer participants' questions and communicate in the participant's preferred language (English or Spanish).

OSF provides the technical facility for effective ethical management and privacy of storing human data so that data collected during this study that can identify participants will be kept confidential. OSF maintains a Data Retention & Destruction Policy so data is protected from unauthorized access, information is maintained only for the required time to reduce risk, and an audit trail is recorded and maintained. OSF database backups are maintained in encrypted snapshots for 60 days. Logs are retained indefinitely. File backups are hosted in Google Cloud Coldline storage indefinitely. Upon deletion by users, files are retained for 30 days before being removed. Researchers entering data on OSF can set sensitive data to private. This will prevent data from being shared outside of approved collaborators. Projects can also be set to "request access" control to enable access requests with review for appropriate credentials. This provides an additional layer of security for posting data to OSF which reduces the likelihood of accidental disclosure of data.

Prior to depositing into OSF, the risk of loss of confidentiality will be minimized by securely storing research data, including PHI, in a Northwell-approved, password-protected, HIPAA complaint database. No paper documents with personal identifiers will be kept. The Principal Investigator (PI) will be responsible for ensuring that the confidentiality of the data is maintained at all times. All data will be obtained specifically for research purposes. Participant data will be assigned a code number and separated from the participants' name or any other information that could identify him/her. The research file that links identifiable information to the study

code will be kept in an encrypted data file and only the PI and IRB-approved study staff will have access to the file or any other electronic research file. All these activities will be conducted with rigor, reproducibility and Open Science best practices.

Oversight of Data Management and Sharing
Describe how compliance with this Plan will be monitored and managed, frequency of oversight, and by whom at your institution (e.g., titles, roles)

Compliance with this plan will be monitored by the Principal Investigator over the course of the funding period during regular reporting intervals (e.g., at the time of annual Research Performance Progress Reports (RPPRs)).

Data Safety and Monitoring Plan

A. The study will be monitored by the Operations Committee (includes the PI, Co-Is, Data Managers/Analysts, and Intervention Program Manager) and the Independent Safety Monitor (Dr. Anthony Vintzileos). The Operations Committee will oversee the trial and conduct reviews to evaluate the accumulated study data for participant safety, study conduct and progress. The Operations Committee will meet weekly during Years 1-2 and bi-weekly Years 3-5 to review data on screening, recruitment, enrollment, intervention visit attendance, data collection completion, retention, reasons for study withdrawal, and adverse events. A summary of the outcomes from these meetings will be shared with the Steering Committee, who will meet every other month. Necessary reports (e.g., adverse and serious adverse events) will be submitted to the IRB and NINR staff by Ms. Ephraim (Co-Investigator/ Project Director).

   Dr. Anthony Vintzileos is the Chief Patient Safety Officer for Obstetrics at Northwell Health. He will serve as the Independent Safety Monitor and will be available to the study team in real time to review and recommend appropriate actions regarding adverse events and other safety issues among birthing participants.

B. Monitoring of data and study safety will be ongoing by the Operations Committee who will meet weekly during Years 1-2 and bi-weekly Years 3-5. Ms. Ahn and Ms. Silvia will work together to prepare regular recruitment, enrollment, retention and safety reports. These reports will be discussed at weekly Operations and bi-monthly Steering Committee meetings. Baseline study data will be summarized and provided to the Operations and Steering Committees by study arm to examine data quality and equivalence of means and/or medians between groups (this study is blinded to outcome data collection). One-month and 1-year postpartum data will be summarized in aggregate and examined only for data quality (means, medians, ranges) prior to completion of the trial.

   Auditing of a sample of selected cases and verification of source documents will be conducted by the Northwell Health Institute of Health System Science Regulatory Affairs Core in Year 2 to assess compliance with IRB requirements. In addition, the Feinstein Institutes for Medical Research Office of Research Compliance provides comprehensive regulatory oversight of research throughout Northwell Health to ensure the responsible conduct of research. This includes auditing and monitoring to promote adherence to applicable laws, regulations and institutional policy. The Northwell IRB also conducts consent form audits of research requiring continuing review annually, in addition to general assessment of compliance to IRB requirements. To minimize loss of confidentiality, the primary risk of this research, we will put the following procedures in place:
   a. Informed Consent - We plan to apply for a waiver of written HIPAA authorization for the study team to extract potential participant data from the EHR to do targeted recruitment. In addition, we will apply for a waiver of signed informed consent for potential participants to complete the eligibility screening process with study staff, and, if eligible, to provide verbal consent to enroll in the study over the phone. Verbal consent from each enrolled participant will be documented in the REDCap tracking system. Participants may withdraw their consent to participate in the study at any time without loss of benefits to which they are entitled.
   b. Confidentiality - To minimize the risk of inappropriate disclosure of protected health information (PHI) by study and intervention team members, everyone will be trained in standard Northwell Health and Feinstein Institutes for Medical Research protocol for what types of information can and cannot be left on answering machines or with household members or work colleagues, and these rules will be reviewed with the participants. All study and intervention team members will also receive extensive annual training in privacy protection and HIPAA requirements. In addition, any research-specific communications directed to study participants by study and intervention staff must be approved by the IRB first, which provides an added level of assurance that PHI will not be inadvertently disclosed.

C. Data Monitoring Plan: The Operations Committee will oversee the data monitoring plan including data quality, management, confidentiality and security.

a. <u>Data integrity procedures.</u> Clinical measures (e.g., severe maternal morbidity indicators, preeclampsia, and maternal healthcare utilization data) will be extracted from the Perinatal Data Center and the electronic health record (EHR). Questionnaire data (e.g., social support domains and physical activity measures) will be interviewer-administered at baseline and administered via REDCap email link at 1-month and 1-year postpartum and data will be stored in REDCap. Process measures such as responses to OB-Chat, completion of telehealth visits, navigation notes, and social needs will be tracked by study team members in a secure, electronic tracking system called Care Tool (currently used by the MOMs team) and in the EHR. Data collectors will be trained and overseen by the Project Director (Ms. Ephraim) and the Senior Research Coordinator (Ms. Polo) to ensure adherence to questionnaire data collection protocols. We will also utilize REDCap to develop a tracking system to track participant recruitment progress and enrollment.

b. <u>Security measures.</u> Sensitive and confidentiality data collected as part of this research will be protected from inadvertent disclosure and release. Any personally identifiable information collected will be housed in REDCap, which is a HIPAA-compliant, web-based application. Additional information about REDCap can be found at the following link: project-redcap.org/. The Quantitative Intelligence group within the Feinstein Institutes for Medical Research runs a private version of REDCap, which it hosts on a secure server. Servers are protected and monitored for any unusual or malicious activity. Access to personally identifiable information will be limited through proper access controls such as password protection and other means. REDCap applies user rights settings that uniquely identify all users and log their activities. These internal security settings determine the access and privileges of the signed-in user. Northwell's EHR system is also secure and protected by firewalls and use is limited to those with approved permissions. Any portable electronic devices used in this research (e.g. laptops) will be encrypted to safeguard data and information.

c. <u>Data handling practices.</u> Use of REDCap in this project conforms to guidelines for Good Clinical Practice (GCP) as articulated in 5.5.3. REDCap is designed to permit data changes in such a way that the data changes are documented and standard operating procedures (SOP) for use of REDCap will be established to ensure there is no deletion of data. All data will be reviewed and managed by study Data Managers/Analysts to ensure completeness and accuracy. The Data Managers will also ensure there is adequate backup of data captured in REDCap. Access to data will be limited to members of the Operations Committee and other study team members with relevant need and approval.

d. <u>Quality assurance measures.</u> Data Managers/Analyst will review the data weekly for completeness and accuracy and to maintain quality assurance and quality control as per GCP 5.1.1. Any issues will be reported to the Project Director and Senior Research Coordinator who will further assess data integrity, validity, and protocol compliance and conduct any re-training of data collectors as needed. The data will be made available for the purpose of monitoring and auditing by regulatory authorities, as requested.

e. <u>Confidentiality.</u> We will follow strict procedures to assure the security and integrity of all study data. All research databases include only study ID and no personal identifiers. Access to project data will be restricted to authorized personnel, password-protected, and closely monitored for intrusion. In addition, to reduce any risk of disclosure of confidential information, participants' privacy and confidentiality will have been ensured by:

- Securely storing all identifiable data in password-protected files and directories on investigator computers within firewall-protected networks.
- Removing or obscuring participant names and identifying features prior to any presentation, publication, or other sharing of data outside the research team, except with the express written consent of participants.
- Granting access to unmodified data (containing identifying data or features) only to members of the research team or the participant's care team (including providers) working under the direction of the investigators for the duration of the study.
- Shredding of any printed or written materials with PHI at completion of the trial and in compliance with IRB policy.

In addition, as an additional level of protection for human subjects involved in clinical studies, a Certificate of Confidentiality, will be issued as a term of this award to provide special privacy protection to subjects involved in clinical research.

D. This project proposes a comprehensive (systematic and non-systematic) collection of reported events to determine if an adverse event has occurred, and to determine next steps, if any, for reporting. Information on AEs will be monitored via the EHR and participant self-report. We will look for hospitalizations and any outpatient encounters related to an injury or other medical concerns (e.g., elevated blood pressure, elevated or low blood sugar) every 6 months. In addition, events reported by participants that meet the definition of an adverse event during the time frame specified in the protocol (e.g. from the start of intervention through the end of the study) will be collected in electronic format using REDCap. These reported events will be examined for potential relevance to the study. A report of safety events, if applicable, will be generated for weekly Operations and bi-monthly Steering Committee meetings. We do not expect events that would halt accrual to occur.

DEFINITIONS

Adverse Event (AE):
An unfavorable change in the health of a participant, including abnormal laboratory findings, that happens during a clinical study or within a certain amount of time after the study has ended. This change may or may not be caused by the intervention/treatment being studied. The Northwell Health IRB further defines AEs to encompass both physical and psychological harms.

Serious Adverse Event (SAE):
Any adverse event that:
- Results in death
- Is a life-threatening experience
- Hospitalization (for a person not already hospitalized)
- Prolongation of hospitalization (for a patient already hospitalized)
- Persistent or significant disability or incapacity
- Congenital anomaly and/or birth defects
- Event that jeopardizes the subject and may require medical or surgical treatment to prevent one of the preceding outcomes.

Unanticipated Problem (UP):
Defined by DHHS 45 CFR part 46 as any incident, experience, or outcome that **meets all the following criteria:**
- unexpected, in terms of nature, severity, or frequency, given (a) the research procedures that are described in the protocol-related documents, such as the IRB-approved research protocol and informed consent document; and (b) the characteristics of the study population;
- related or possibly related to participation in the research (in this guidance document, possibly related means there is a reasonable possibility that the incident, experience, or outcome may have been caused by the procedures involved in the research);
- suggests that the research places participants or others at a greater risk of harm (including physical, psychological, economic, or social harm) than was previously known or recognized.

CLASSIFYING ADVERSE EVENTS
An event's severity, expectedness, and potential relatedness to the study intervention will be classified according to the below:

Severity
- **Mild**: Awareness of signs or symptoms, but easily tolerated and are of minor irritant type causing no loss of time from normal activities. Symptoms do not require therapy or a medical evaluation; signs and symptoms are transient.

- **Moderate**: Events introduce a low level of inconvenience or concern to the participant and may interfere with daily activities but are usually improved by simple therapeutic measures: moderate experiences may cause some interference with functioning.
- **Severe**: Events interrupt the participant's normal daily activities and generally, require systemic drug therapy or other treatment; they are usually incapacitating

Expectedness

AEs will be assessed as to whether they were expected to occur or unexpected, meaning not anticipated based on current knowledge found in the protocol, investigator brochure, product insert, or label. Categories are:

- **Unexpected** - nature or severity of the event is not consistent with information about the condition under study or intervention in the protocol, consent form, product brochure, or investigator brochure.
- **Expected** - event is known to be associated with the intervention or condition under study.

Relatedness

The event's potential relationship to the study intervention and/or participation is assessed according to the below:

- **Related:** An event is "related" if it is likely to have been caused by the research procedures.
- **Probably/Possibly Related:** An event is considered to be probably or possibly related to the intervention if there is a greater than 50% chance that the event was caused by the study procedures.
- **Unrelated**: The adverse event is clearly not related to the research - i.e., another cause of the event is most plausible; and/or a clinically plausible temporal sequence is inconsistent with the onset of the event and the study intervention and/or a causal relationship is considered biologically implausible.

REPORTING PROCESSES

- All **adverse events that are serious** (SAE), **unexpected** (have not been defined as expected) and **related** to the research will be reported to the NINR Program Officer and the study's Independent Safety Monitor within 48 hours of discovery. Reporting to the Northwell Health IRB will not exceed **5 business days** of the study's knowledge of the SAE to coincide with the local site's standard operating procedures for reporting.
- **Unanticipated Problems (UP)** will be reported to the Northwell Health IRB within **5 business days** of the study's knowledge of the event to coincide with the local site's standard operating procedures for reporting. Events that are determined by the Northwell Health IRB to meet the criteria of an Unanticipated Problem as defined above will be reported to the NINR Program Officer and the study's Independent Safety Monitor within **5 business days** of that determination. A report will be submitted to OHRP by the Northwell Health IRB as per 45 CFR 46(a)(4)(i), and according to the IRB's standard operating procedures for reportable events.
- All other adverse events (events that meet the definition of an AE, but are not unanticipated problems or an unexpected, related SAE) do not require reporting to the Northwell Health IRB as per local policy. These events will be reported to the Independent Safety Monitor and NINR Program Officer **annually**, or at a frequency requested by NINR Program Officer.

Any event that results in a protocol change to protect the rights and welfare of participants in the research will be reported to NINR staff within 7 days of approval by the Northwell Health IRB. In addition.

E. This is a single-site study.

F. The Northwell Health IRB, requires submission of recent literature, findings or other relevant information, especially information about risks associated with the research, at the time of continuing review. Study team members will stay up to date on any developments in the literature, new clinical

practice policies or guidelines, or related studies that may have an impact on the safety of participants or on the ethics of the research study. If such external factors or relevant information is identified and does have an impact on participant safety or study ethics, then study protocols will be updated and submitted for approval by the IRB and NINR in a timely fashion.

G. Interim analysis will not be conducted given the minimal risk of the research.

1. **Human Subjects**
   a. *Human Subjects Involvement, Characteristics, and Design*
   We plan to recruit 674 participants (586 target sample size + 15% attrition) who meet the following criteria:
      - Age 18 or older
      - Self-identify as Black/ African American
      - Pregnant, < 12 weeks gestational age
      - OB-CMI risk score ≥ 3 and/or history of preeclampsia
      - English or Spanish as primary language
      - Receive obstetrics care at a Northwell Health Physician Partners OB practice site

   Birthing people who are not able to provide informed consent due to cognitive or psychiatric impairment will be excluded. Because this is a pragmatic trial, exclusion criteria are minimal.

   This is a pragmatic, randomized clinical trial design. Randomization will be at the patient level and patients will be randomized to one of two study arms: 1) MOMs High-Touch (MOMs-HT); and 2) MOMs Low-Touch (MOMs-LT).

   b. *Study Procedures and Materials*
   Recruitment. In Year 1, an algorithm will be developed to help identify eligible birthing people based on the inclusion criteria using data from the electronic health record (EHR), including the Northwell Perinatal Data Center. The algorithm will run daily to create a recruitment list. Research assistants will mail and email recruitment letters, which will be followed by recruitment phone calls. During these calls, research assistants will give an overview of the study. Interested birthing people will then be screened over the phone to confirm eligibility based on inclusion criteria, including OB-CMI risk factors. Research assistants will then obtain informed consent and administer baseline questionnaires.

   Recruitment Tracking. We will utilize REDCap to develop a tracking system to track participant recruitment progress and enrollment. REDCap is a HIPAA-compliant, web-based application. Additional information about REDCap can be found at the following link: project-redcap.org/. The Quantitative Intelligence group within the Feinstein Institutes for Medical Research run a private version of REDCap, which it hosts on a secure server. Servers are protected and monitored for any unusual or malicious activity. REDCap applies user rights settings that uniquely identify all users and log their activities. These internal security settings determine the access and privileges of the signed-in user.

   Randomization Assignment. Enrolled birthing people will be randomized at a 1:1 ratio to one of the two study arms, MOMs-HT or MOMs-LT.

   MOMs-HT. Participants randomized to MOMs-HT will be enrolled in OB-Chat, a personalized care digital conversation chatbot that sends weekly "chats" via text message or email throughout the prenatal and postpartum periods. OB-Chats will facilitate clinical, behavioral health, and social need check-ins and will escalate any alerts or concerns to the 24/7 nurse led call center within the MOMs Program. A nurse will follow-up via phone call to navigate the participant to clinical, behavioral health, or social services as needed.

   In addition to OB-Chat, participants in this arm will receive 12 bi-weekly prenatal telehealth visits delivered by a MOMs care management coordinator (CMC) or registered nurse (RN) via phone call or videoconferencing. Each visit the CMC or RN will conduct a clinical and behavioral health check-in, navigate the participant to clinical or social services as needed, screen for social needs (initial telehealth visit), follow-up on referrals to resources to address social needs, and provide self-management support. Self-management support will consist of assessing progress with engagement in self-management behaviors since the last visit, including asking about minutes and type of physical activity, self-monitoring (blood pressure, blood sugar, weight), and taking medications. CMCs and RNs will also facilitate goal setting and problem solving with participants to set realistic physical activity and

other behavioral goals and identify and address barriers (including social needs) to engaging in behavior change.

Lastly, the CMC or RN will conduct brief clinical check-ins via phone call at 24- and 72-hours post-delivery. These brief clinical check-ins will be followed by 4-weekly postpartum telehealth visits that will also involve clinical, behavioral health, and social need check-ins, navigation to clinical and social services, and self-management support as needed.

MOMs-LT. Participants randomized to MOMs-LT will be setup with OB-Chat during the study randomization/enrollment call. MOMs-LT participants will also have access to OB-Chat from the time of enrollment during the prenatal period to 1-year postpartum. Similar to MOMs-HT, clinical, behavioral health, and social need alerts identified via weekly OB-Chats will be routed to the 24/7 nurse-led call center within the MOMs Program. Close to delivery, a CMC or RN will be assigned to participants enrolled in MOMs-LT to conduct clinical check-in calls 24 and 72 hours after labor and delivery. The CMC or RN will continue with 4 weekly clinical check-ins via phone or videoconferencing during the first month postpartum. Navigation to clinical, behavioral health, and social services will be provided as needs are identified. In this arm CMCs and RNs will not provide intensive self-management support, but may remind participants about upcoming appointments, blood pressure monitoring, and taking medications.

Overview of Data Collection. Clinical measures (e.g., severe maternal morbidity indicators, preeclampsia, and maternal healthcare utilization data) will be extracted from the Perinatal Data Center and the EHR. Questionnaire data (e.g., social support domains and physical activity measures) will be interviewer-administered at baseline and administered via REDCap email link at 1-month and 1-year postpartum and data will be stored in REDCap. Process measures such as responses to OB-Chat, completion of telehealth visits, navigation notes, and social needs will be tracked in a secure, electronic tracking system called Care Tool (currently used by the MOMs team) and in the EHR. Participants will receive a $25 debit card for completing each data collection call.

c. *Potential Risks*
Because the purpose of the two study arms is to closely monitor, navigate, and support Black birthing people during the prenatal and postpartum periods, we believe that these interventions carry no incremental health risks. That is, we believe the study carries no individual level health risks above and beyond what might be expected as part of usual care. Indeed, we are facilitating and enhancing usual care by making sure any potential risk and/or emergencies during the birthing continuum are immediately addressed by the participant's care team.

In terms of the study, the most serious of risks is a breach of confidentiality. This could happen if, for example, confidential information collected by study staff or extracted from the EHR was inadvertently disclosed to personnel outside of the study or intervention team. All study and intervention team members will be required to complete research with human subjects training. No individual-identifying data will be published or released, and data will be summarized and presented in public forums only in de-identified or aggregate form.

2. Adequacy of Protection Against Risks
a. *Informed Consent*
We plan to apply for a waiver of written HIPAA authorization for the study team to extract potential participant data from the EHR to do targeted recruitment. In addition, we will apply for a waiver of signed informed consent for potential participants to complete the eligibility screening process with study staff, and, if eligible, to provide verbal consent to enroll in the study over the phone. Verbal consent from each enrolled participant will be documented in the REDCap tracking system. Participants may withdraw their consent to participate in the study at any time.
b. *Protections Against Risk*
Elevated Blood Pressure. Hypertensive disorders of pregnancy may occur among study participants; therefore, we will implement the current protocol used by the MOMs Program to ensure participant safety. Specifically, if participants report elevated blood pressure (> 140/90 mm Hg) and any associated

symptoms (e.g., headache, blurry vision, shortness of breath, edema) via OB-Chat or during a clinical check-in, a RN on the MOMs team will immediately notify the OB provider to follow-up. Depending on the severity of the blood pressure value and reported symptoms, the participant may also be navigated to emergency care services.

<u>Depression and Anxiety.</u> Participants will be screened regularly for symptoms of depression and anxiety as part of the clinical and behavioral health check-ins during the prenatal and postpartum periods. If participants express thoughts/feelings of harming themselves and/or their infant, study and intervention staff will immediately call 911. For elevated symptoms of depression without suicidality or anxiety, study and intervention staff are instructed to refer the participant to the Crisis Clinic (urgent need) or the Behavioral Health Services (non-urgent need) at the Zucker Perinatal Psychiatry Clinic.

<u>Confidentiality.</u> To minimize the risk of inappropriate disclosure of protected health information (PHI) by study and intervention team members, everyone will be trained in standard Northwell and Feinstein Institutes for Medical Research protocol for what types of information can and cannot be left on answering machines or with household members or work colleagues, and these rules will be reviewed with the participants. All study and intervention team members will also receive extensive annual training in privacy protection and HIPAA rules. In addition, any communications directed to study participants by study and intervention staff must be approved by the IRB first, which provides an added level of assurance that PHI will not be inadvertently disclosed. Finally, we will follow strict procedures to assure the security and integrity of all study data. All research databases include only study ID and no personal identifiers. Access to project data will be restricted to authorized personnel, password-protected, and closely monitored for intrusion.

In addition, to reduce any risk of disclosure of confidential information, participants' privacy and confidentiality will have been ensured by:
- Securely storing all identifiable data in password-protected files and directories on investigator computers within firewall-protected networks.
- Removing or obscuring participant names and identifying features prior to any presentation, publication, or other sharing of data outside the research team, except with the express written consent of participants.
- Granting access to unmodified data (containing identifying data or features) only to members of the research team or the participant's care team (including providers) working under the direction of the investigators for the duration of the study.
- Shredding of any printed or written materials with PHI at completion of the trial and in compliance with IRB policy.

c. Vulnerable Subjects
Black birthing people/pregnant women are considered a vulnerable population given that they represent a sub-segment of the community requiring high quality care and special considerations and protections in research. As previously described, we believe the study carries no health risks above and beyond what might be expected as part of usual care and, in fact, participation in this study may help to facilitate and enhance usual prenatal and postpartum care. Furthermore, we have protocols and workflows in place to address any potential risk or emergencies that may occur during the prenatal and postpartum periods (e.g., elevated blood pressure, behavioral health concerns). We do not plan to collect any information on the infant as part of this study.

3. Potential Benefits of the Proposed Research to Research Participants and Others
Participants will benefit from the close clinical monitoring, navigation to services, and self-management support that will be provided.

4. Importance of the Knowledge to be Gained
There is a maternal health crisis in the US and there is a need for effective interventions to address maternal health inequities. Furthermore, the feasibility and effectiveness of integrated care approaches throughout the birthing continuum needs to be further established. Findings from this study will shed light

on the effectiveness of a patient-centered, integrated maternal care model approach to reduce racial and ethnic disparities in the prevalence of severe maternal morbidity.