Expanding Human Factors/Ergonomics to Address Social Determinants of Health: A Patient Ergonomics Approach to Birth Justice

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Abstract

Human factors/ergonomics (HF/E) is well equipped with theories, frameworks, and methods to contribute to advancing social justice. One way to extend H/FE to improve health equity is to apply the discipline to address the Social Determinants of Health (SDOH). Using a patient ergonomics approach, this research sought to extend sub-factors of the patient work system to encompass SDOH. Employing methodologies and methods from HF/E and public health through a case study focused on transportation access to maternal health services, interviews were conducted with 20 health care and human services professionals and 18 birthing persons of color with low-income to elucidate sub-factors within the patient work system. From these interviews, systems maps were created and reviewed by participants to capture interactive relationships between and among sub-factors and outcomes. This research corroborated existing sub-factors and identified unique sub-factors of the patient work system, expanding our current understanding of the dimensionalities of the patient work system. Through systems mapping, interactions were found across all domains of the patient work system. Models of patient work should be expanded to purposefully incorporate a range of work system factors that stem from SDOH and explicate their interactions. Multi-dimensional interventions should be co-designed with communities to address the complexities of transportation access to maternal health services. This dissertation research demonstrates that HF/E researchers and practitioners can contribute to our knowledge of systems modeling in concerted efforts with other disciplines as well as use participatory approaches to produce holistic understandings of systems and generate interventions that seek to eliminate the health inequities produced by these systems.

Preface: A Note on Researcher Perspective and Methodology

Engineering as a field has traditionally taken an objectivist approach, specifically engrained in positivist and quantitative paradigms. However, researchers are not outsiders in the research process, they are connected in complex ways to sociopolitical and sociotechnical systems. Particularly in the Western world, engineering research has been engrained in the White perspective and silenced perspectives of marginalized populations. Considerations for power and history need to be integrated into our epistemological paradigms. To begin this epistemological shift, this dissertation research sought to engage community partners as equals in the research process, from the development of research questions and study design to the collection and analysis of data, as well as the dissemination and implementation of research findings. From an epistemological perspective, I took a constructivist approach, meaning that knowledge is co-constructed between the researcher and the research context. As social and cultural factors shape scientific knowledge, it is important to acknowledge my own assumptions, biases, and values so that those reading the content in this dissertation can consider how my perspectives shape the research being reported.

First and foremost, I am a White woman from a middle class upbringing. I grew up in the United States and English is my primary language. I recognize my privileged position in society and that this privilege influences my understanding of the experiences and perspectives of those who participated in this research. Though I am aware of the historical and systemic factors that have created systems of oppression that have had inequitable and unjust impacts on marginalized populations, I will never be able to fully understand the lived experience of a person of color. I continually reflected on my own biases and assumptions throughout this research process.

When developing this dissertation research, I grounded the methodology in community-based participatory research, where my community partners identified the topic area of interest. The process of beginning to form community partners began six years ago when I worked at the Richmond City Health District for two years. As I moved into a PhD program, I wanted my dissertation research to focus on a topic that could be valuable to the Health District as well as other partners around Richmond. In conversations with colleagues, there was

a need to explore further transportation access to maternal health services in the region among low-income individuals. Starting with the expressed need from the community, I then started to think about how we could examine this issue scientifically from both public health and human factors engineering perspectives. It is my hope that this dissertation serves as a catalyst for change in engineering research, where the democratization of research process allows for inclusive and intentional progress towards an equitable and just society.

Chapter 1 Introduction

1.1 Progressing Human Factors/Ergonomics to Advance Social Justice

Societal challenges are complex, multi-dimensional, and multi-level problems that typically exist at a global scale (University of Minnesota, 2016). Examples of these challenges include the coronavirus pandemic, climate change, and food insecurity. Such challenges may impact all individuals but often have a disproportionate negative impact on those who hold one or more marginalized identities. These identities include those related to race, ethnicity, gender, age, income, ability, education, sexual orientation, caste, among others. The negative differential impacts on marginalized populations are due, in large part, to unequal power relationships across economic, political, social, and cultural dimensions (National Collaborating Centre for Determinants of Health, 2022). Pervasive and persistent discrimination and exclusion through these power structures has resulted, over time, in large-scale systems of oppression (e.g. racism, ageism, sexism, ableism, casteism, and colonialism).

Although fields that have traditionally emphasized technical solutions (e.g. engineering and urban planning) have meaningfully contributed to addressing components of societal challenges, such efforts have typically been highly circumscribed rather than addressing these challenges through a holistic perspective, accounting for both social and technical elements and their interactions. Moreover, differential impact on marginalized populations is rarely prioritized and these fields have even contributed to such inequities. For example, using climate change as a societal challenge, in South Africa, urban green infrastructure is unequally distributed across race and income geographies, following historical patterns of Apartheid-era segregation (Venter et al., 2020). As a direct result of racial segregation and intentional divestment, these communities will experience differential impact of climate change because they are more vulnerable to heat waves and extreme weather events (Hendricks & Van Zandt, 2021). In another example, referencing ethical artificial intelligence as a societal challenge, facial recognition technology mischaracterizes transgender and non-binary individuals, which perpetuates feelings of isolation and alienation from society (Scheuerman et al., 2019). These

examples illustrate that the technical components of engineering are intimately intertwined with the social aspects. However, the distinct conceptualization and separation of the technical and social, known as technical-social dualism, is deeply embedded in education within traditionally technical fields and consequently, in their research and practice (Cech, 2013).

The discipline of human factors/ergonomics (HF/E) recognizes and seeks to account for the interdependence of the technical and social aspects of systems (Carayon, 2006). As such, H/FE is well equipped with theories, frameworks, and methods to contribute to collaborative efforts with other disciplines as well as with marginalized communities to address societal challenges. However, a majority of the applications of the discipline have historically been confined to challenges that exist at lower levels of scale and complexity in tightly bounded systems without such wide-ranging interdisciplinary partnerships and intentional involvement of marginalized communities (Sinclair et al., 2021; Thatcher et al., 2018). With the widespread reorientation of HF/E to be applied to social justice issues, the discipline can move further towards its goal of promoting the health and safety of all humans.

1.2 Addressing the Social Determinants of Health through a Patient Ergonomics Approach

One way to extend H/FE to advance social justice is to apply the discipline to address the Social Determinants of Health (SDOH). From the public health literature, SDOH are "the conditions in the places where people live, learn, work, and play that affect a wide range of health risks and outcomes" (Centers for Disease Control, 2021). Determinants such as income level, education, and access to safe housing affect about 50% of health outcomes, while clinical care impacts only 20% of health outcomes (Whitman et al., 2022). As such, greater investments in clinical care as opposed to social programs in the United States has resulted in the lowest life expectancy and highest suicide rates among the OECD countries (Tikkanen & Abrams, 2020; Tikkanen & Schneider, 2020). Partnerships across sectors, including but not limited to health systems, human services agencies, policymakers, non-profit organizations, and communities, can contribute to improving health outcomes by attending to SDOH. By engaging in concerted efforts, health care quality can be improved by aligning recommendations with individual contextual realities (Ozkaynak, Valdez, et al., 2021) and overall public health can be improved through developing multi-level interventions to address SDOH (Agency for Health Research and

Quality, 2020). These efforts are especially needed in partnership with marginalized populations, who are disproportionately affected by adverse determinants of health (e.g. poverty, exposure to pollution, and racism) (Baah et al., 2019), as addressing SDOH is currently the primary approach to improving health equity (Centers for Disease Control & Prevention, 2019).

Human factors/ergonomics (HF/E) is uniquely positioned to study SDOH as the field focuses on designing to promote human wellbeing in complex sociotechnical systems. SDOH are starting to be considered as factors influencing patient work, which is defined as "exertion of effort and investment of time on the part of patients or family members to produce or accomplish something" (Strauss, 1993). Patient work is shaped by the work system, which includes three levels of the person-task-tools triad, household, and community that exists within the social, organizational, and physical domains (Holden et al., 2017a). These contextual environments include SDOH. The application of HF/E to study patient work and patient work systems has emerged into a new research area referred to as patient ergonomics (Holden & Valdez, 2021; Valdez & Holden, 2021). Patient ergonomics research has often studied how work that has a strong clinical component (e.g. medication and symptom management (Holden et al., 2015a, 2017a; Holden & Abebe, 2021)) is shaped by work system factors related to SDOH. For example, medication and symptom management are shaped by factors in the physical environment, such as proximity to a pharmacy and safe places to exercise. Though the importance of SDOH is recognized in patient work systems models (Benda & Creber, 2021; Rogers et al., 2022), these models need to be extended to fully encompass SDOH in order for HF/E to meaningfully contribute to improving health equity.

1.3 Case Study: Transportation Access to Maternal Health Services

As the study of SDOH in the patient work system is emergent for patient ergonomics research (Holden & Valdez, 2021; Valdez & Holden, 2021), one way to begin research in this area is to determine a case focused on a singular SDOH that significantly affects multiple domains of the patient work system and produces interactions across these domains. Transportation access is one such determinant. Structural racism embedded in the design of transportation systems has resulted in disproportionately low access to health care and public

services in minority communities (Bullard et al., 2004; Enright, 2019; Pereira et al., 2017). Inequities in transportation systems can be traced back to redlining, an historical injustice where minorities were denied access to mortgages, which resulted in racially segregated neighborhoods and economic deprivation due to government divestment (Greer, 2013; Nardone et al., 2020). This divestment has produced areas with low walkability and limited access to public transportation (US Department of Transportation, 2015; Woolf & Braveman, 2011), making it harder for individuals in these communities to travel to jobs, resources, and services (Urban Institute, 2020).

Within a case study of transportation access, a specific condition and population can be determined to further bound the system. The maternal care continuum provides a rich environment to study patient work stemming from transportation access as there are frequent needs to attend health care appointments in addition to services and programs that promote health during and after a pregnancy. Transportation access affects prenatal care utilization, access to postpartum care, and the management of underlying chronic conditions during a pregnancy (Gadson et al., 2017; Syed et al., 2013). Though there are inequities in maternal health outcomes across marginalized identities, people of color are one population who continuously experience adverse maternal outcomes (Hoyert, 2022). There are significant racial and ethnic disparities in maternal mortality, with mortality ratios being approximately two to three times higher among Alaskan Native/Native American and Black individuals, respectively, than non-Hispanic White individuals (Centers for Disease Control and Prevention, 2020). Moreover, Hispanic individuals have higher rates of severe birth-related issues than non-Hispanic White individuals (Admon et al., 2018). These disparities are further exacerbated by income status (Maternal Health Task Force, 2015). Low income individuals are more likely to experience housing instability, which can lead to complications during a pregnancy and subsequent adverse outcomes (Clark, 2017; Pantell et al., 2019). As the poverty rates for racial and ethnic minority populations are more than double the rate for non-Hispanic White populations (Kaiser Family Foundation, 2021), low income minority individuals are more likely to live in substandard housing that has been shown to be disproportionately segregated from public resources (National Women's Law Center, 2021). Furthermore, low-income populations

of color tend to have higher rates of chronic conditions, like cardiovascular conditions, that contribute to pregnancy complications (Howell et al., 2018). The ability to manage chronic conditions as well as promote a healthy pregnancy through diet and nutrition is hindered by the availability of affordable and nutritious foods. Low-income individuals are more likely to experience food insecurity (Coleman-Jensen et al., 2018) and low-income minority populations have limited transportation access to full-service grocery stores (Powell et al., 2007). Food insecurity is also influenced by cultural preferences and language barriers (K. S. Gorman et al., 2017; Vahabi & Damba, 2013). There are racial and ethnic disparities as well in maternal mental health among low income individuals, with populations of color being less likely to initiate and receive follow-up treatment (Kozhimannil et al., 2011). Taken together, the intersectionality of race/ethnicity and class results in a population that is the most vulnerable to adverse maternal health outcomes. Studying transportation access within this population provides a uniquely complex case to begin to understand how HF/E, can contribute to enhancing the patient work system with sub-factors specific to SDOH. Enhancing the patient work system in this manner produces holistic models of the systems that produce health inequities, allowing for better identification of intervention points to mitigate these inequities.

1.4 Current Understanding of Transportation Access to Maternal Health Services

Our current understanding of transportation access to maternal health services in the US is limited mainly to quantitative and geospatial data (Holcomb et al., 2021; Liu & Liu, 2016), with few qualitative studies focused on investigating in-depth the experiences and perspectives of transportation access to these services (Ayers et al., 2018; Panzera et al., 2017). Quantitative and geospatial data are helpful to our understanding of transportation barriers among low income individuals as it has identified the geographic distribution of services, the distance an individual would have to travel to get to a service location from a low income community, and how long it may take to get there by private or public transportation (Brantley et al., 2017; Holcomb et al., 2021; Matthews et al., 2019). Qualitative research can help to elucidate elements of the cultural, social, political, and technological environments that affect transportation access as the experience of accessing transportation goes beyond what can be understood through these methods of quantification. For example, the process of coordinating

transportation is shaped by social and cultural aspects like asking family, friends, or community members for rides. Additionally, accessing public transportation is affected by the ability to understand routes and schedules, which is further influenced by factors such as primary language and literacy levels. This experience is often not known to health care and human service professionals as there is a dearth of research in the US that explores perceived barriers among these professionals to accessing maternal health services (Ayers et al., 2018), let alone research that explores perceptions of transportation access in depth. Moreover, the qualitative studies that have been conducted are limited in scope as they only explore transportation access to singular types of services and do not consider access to the spectrum of maternal health services ideally utilized during and after a pregnancy (Lia-Hoagberg et al., 1990; Panzera et al., 2017). Without knowing in-depth details about the experience accessing transportation to maternal health services, our understanding of the system is incomplete, and thus our ability to design interventions that attend to contextual realities is limited.

1.5 Merging HF/E and Public Health

As this dissertation seeks to apply H/FE models to examine SDOH, a framework from public health, the strengths and weaknesses of relevant concepts and conceptual models from both disciplines need to be considered. Moreover, research agendas should be aligned so that this dissertation can yield benefits for both fields.

1.5.1 Concepts

HF/E methodologies that examine the contextual social factors such as policy, politics, culture, and history have primarily been developed and used in bounded, organizational environments. Participatory ergonomics is one such methodology that has a history of producing successful interventions in organizational environments by including employees in the design process (Burgess-Limerick, 2018; Haims & Carayon, 1998; Haines et al., 2002; Hendrick, 2007; Hignett et al., 2005). For this research, participatory ergonomics can be extended to environments outside of organizations by enhancing it with tenets of approaches from public health that have a history of engaging marginalized populations. Community-based participatory research (CBPR) is an approach out of the public health tradition in which

researchers and community stakeholders engage as equal partners in all steps of the research process (Israel et al., 1998). The goal of this approach is to collectively produce evidence for social change. The use of CBPR improves the credibility of the research as well as enhances the usefulness of the research to the community, increasing the likelihood of the research being translated into practice (Holkup et al., 2004; Israel et al., 1998; Stevens & Hall, 1998). Most importantly, this approach helps to mitigate issues of trust, especially in historically marginalized communities that have been exploited by the scientific community (Israel et al., 2001; Stevens & Hall, 1998; Webb, 1990). The proposed research leverages the tenets of CBPR as described in more detail in the methods section.

1.5.2 Conceptual Models

The socio-ecological model has traditionally been used in public health as a systems perspective to understand the factors that influence health and well-being, including SDOH (Berger et al., 2016; Heaman et al., 2015; Russell et al., 2013). However, this model is limited in that it does not explicitly account for other factors that are known to affect health (e.g., technology), interactions, and change over time. As a more holistic approach, work systems models from human factors engineering have been adapted for health care and may provide a unique perspective by addressing the limitations of the socioecological model (Carayon et al., 2006; Holden et al., 2017a; National Research Council, 2011; Ozkaynak et al., 2013). Many work system conceptualizations exist (Carayon et al., 2006; Holden et al., 2013; National Research Council, 2011). This work will use the consolidated patient work systems model developed by Holden et al. (Holden et al., 2017a). This model includes the microergonomic triad of person(s)-tasks-tools, household, and community and the three macroergonomic domains of physical, social, and organizational context.

1.5.3 Research Agendas

One priority of the Agency for Healthcare Research and Quality is to improve whole-person care across health care and human services systems (Agency for Healthcare Research and Quality, n.d.). As this dissertation seeks to produce holistic models of work systems, perspectives from two stakeholder groups will be examined: (1) health care and human services

professionals and (2) birthing people of color with low-income. Though not the focus of this dissertation, examining perspectives from professionals and "patients" aligns with an emerging research area in HF/E to elucidate invisible work systems (R. K. Gorman et al., 2018). Patient work that is not seen by others, in particular health professionals, and that is implicitly valued less is known as invisible work (R. K. Gorman et al., 2018; Valdez et al., 2015). In a visible work system, professionals understand components of patient work and their interactions, while in an invisible work system, professionals do not sufficiently understand, misinterpret, or undervalue these components and interactions(R. K. Gorman et al., 2018). Garnering perspectives from multiple stakeholder groups contributes to future work centered on elucidating factors of the invisible patient work system.

1.6 Innovation and Significance

Studies that have focused on identifying contextual factors typically stop once these factors have been identified. However, these factors do not exist in isolation and are shaped by dynamic systems that produce interacting relationships between and among these factors. Systems mapping methods can be used to identify these relationships (e.g. feedback loops and causal pathways), resulting in elucidating complex and nonlinear connections and key intervention pathways (Gillen et al., 2014). Systems mapping originated as an engineering method and was developed for applications to business and policy domains (Gillen et al., 2014). Opportunities to extend this method for use in public health have been noted, including the ability to identify the dynamic complexities inherent in public health issues (Homer & Hirsch, 2006). Early attempts to extend this method have been grounded in an ecological model (Gillen et al., 2014; Homer & Hirsch, 2006, 2006), which the limitations of this model and rationale for the use of a work systems model have been discussed above. Moreover, the applications of this method to public health issues have been decontextualized, meaning that they do not usually include the perspectives of the individuals that are most affected by the issue being mapped (e.g. including health professional rather than patient perspectives) (Gillen et al., 2014; G. Hirsch et al., 2010; G. B. Hirsch et al., 2007). By including multiple stakeholder perspectives, different work system conceptualizations of the same issue can be compared in future work, thus rendering elements of invisible work, visible. Furthermore, by classifying interactions,

interventions can be better designed for the dynamic environments in which they are being implemented.

1.7 Purpose

The objective of this dissertation is to produce an enhanced patient work system model that encompasses SDOH and illustrates the interactions between and among systems factors. Achieving this objective will provide a foundation for future work focused on designing, implementing, and evaluating programmatic, policy, and health IT interventions that cross health care, human service, and community settings. This work will also be used to inform local actions shaped by the community partners involved in this work.

1.8 Research Question

The purpose of this research will be achieved by answering the following research questions: (1) How does the patient work system model need to be extended to encompass the Social Determinants of Health? and (2) In an extended patient work system model that encompasses Social Determinants of Health, what are the relationships between and among systems factors? These questions will be answered by examining one SDOH, transportation access, in the context of accessing maternal health services, through the lens of two study populations: (1) health care and human services professionals and (2) birthing people of color with low-income.

1.9 Organization of this Document

This document contains four additional chapters. Chapter 2 presents the methodology and methods that were used to identify sub-factors in the PWS to encompass SDOH and elucidate their interactions. Chapter 3 presents the results of the study as related to health care and human services professionals. Chapter 4 presents the results of the study as related to birthing people of color with low-income. Chapter 5 includes a discussion of these results, limitations of this study, and avenues for future research.

Chapter 2 Methods

2.1 Overview

This qualitative interpretive study aimed to empirically identify sub-factors of the PWS through the lens of the social determinants of health using a case study of transportation access to maternal health services among birthing people of color with low-income. Approaches grounded in community-based participatory research, public health, and human factors engineering were used to inform data collection and analysis in order to produce conceptualizations of patient work systems among two study populations: (1) health care and human services professionals and (2) birthing people of color with low-income. This study was completed in two phases from August 2021-February 2023. In Phase 1, surveys, semi-structured interviews, and systems mapping were conducted from August 2021-September 2022 with health care and human services professionals. In Phase 2, surveys, semi-structured interviews, and systems mapping were conducted from December 2022-February 2023 with birthing people of color with low-income. Data from the surveys were analyzed using descriptive statistical approaches. Data from the interviews and systems mapping were analyzed using qualitative content analysis methods (Hsieh & Shannon, 2005), specifically directed (deductive) and conventional (inductive) approaches. This research was approved by the Institutional Review Board (IRB) for the Social and Behavioral Sciences at the University of Virginia.

2.2 Community Partnership Building

This research employed the tenets of community-based participatory research (Israel et al., 1998). I had existing partnerships in the community spanning multiple years of work as a field assignee to the Richmond City Health District from the Centers for Disease Control and Prevention prior to starting this research. This research was mainly conducted in partnership with the Greater Richmond Regional Maternal Child Health Collective Impact Taskforce. The topic of this research was determined by members of the taskforce after months of discussion. The partners assisted with recruitment of participants as described below. The findings from

this research will be shared through approaches directed by our community partners with the broader community to initiate action surrounding transportation access to maternal health services in efforts to reduce health inequities in the area. Dissemination activities may include presenting results at local government, non-profit, and community meetings and events as well as posting summary flyers, tailored to the literacy level and culture of the study population, at community-based locations (e.g. local libraries and resource centers).

2.3 Setting

This research focused geographically in the Greater Richmond Region. In this area, racial and ethnic disparities in maternal mortality and morbidity are similar to national rates in VA (Secretary of Health and Human Resources, Office of the Governor of Virginia, 2021). The population of this region includes a majority of people of color (U.S. Census Bureau, 2021). The poverty rate is almost 20%, which is more than double the state-wide average (U.S. Census Bureau, 2021). This region also has a history of inequitable transportation systems (Adhikari et al., 2018). Lastly, there are several health care systems (e.g. Virginia Commonwealth University Health, Bon Secours, and HCA Virginia Health System), about 250 Medicaid providers of OB/GYN services, and numerous public health programs and community-based organizations centered around maternal health (e.g. WIC clinics, community resource centers, and non-profit organizations).

2.4 Phase One: Interviews and Systems Mapping with Health Care and Human Services Professionals

2.4.1 Sample

To be eligible for the study, an individual must have worked in health care or human services in the Greater Richmond Region and be 18 years of age or older. Health care professional was defined as one who "maintains health in humans through the application of the principles and procedures of evidence-based medicine and caring" (World Healh Organization, 2019). Human services professional was defined as one who "helps maintain health in humans by directly assisting or working with health professionals, or by addressing

personal and social issues important to health" (National Organization for Human Services, n.d.).

2.4.2 Setting

Data collection took place remotely on Zoom or over the phone.

2.4.3 Recruitment

Participants were recruited from the Greater Richmond Maternal Health Collective Impact Taskforce. An email on behalf of the research team was sent to the taskforce. If members of the task force were interested in participating in an interview, they could fill out a recruitment survey on Qualtrics asking for basic contact information or contact the study team via email, phone, or text. The recruitment survey is available in Appendix A Exhibit A1. Additional recruitment took place by emailing and calling health care and human services professionals identified through internet searches. Snowball sampling was also employed by asking participants at the end of the interview to provide contact information for anyone who they thought would be interested in participating in the study. Researchers then contacted these potential participants via email or phone. Participants were contacted two times before they were considered loss to follow up.

2.4.4 Data Collection

Interviews were semi-structured in nature. The interview guide was grounded in the domains of the PWS. A consolidated model of the PWS developed by Holden et al. (Holden et al., 2017a) was used as the overarching framework. Questions were developed within the microergonomic triad of person(s)-tasks-tools, household, and community and the three macroergonomic domains of physical, social, and organizational context. The first draft of the interview guide was created by me. This draft was reviewed by two community partners and my dissertation advisor. Their comments were incorporated into the final version. The full interview guide is available in the Appendix A Exhibit A2. Interviews were conducted with the assistance of an undergraduate research assistant trained specifically for this project. This individual was engaged in this research starting in August 2021. Interviews lasted approximately 45 minutes to one hour. Informed consent was obtained prior to starting the interview. A

survey asking for demographic information and information about the organization a participant worked for was distributed via a Qualtrics link at the end of the interview session. The full demographic and organization information survey is available in Appendix A Exhibit A3. Participants received a $25 gift card as compensation for their time. Consent and the interviews were audio recorded and professionally transcribed.

2.4.5 Data Analysis

2.4.5.1 Interviews

Data were coded using both deductive (i.e. the high-level domains of the consolidated PWS model described above) and inductive approaches (Hsieh & Shannon, 2005). Data were analyzed using QSR NVIVO (QSR International, 2023). The first transcript was independently coded by both the undergraduate research assistant and me. Consensus building (Saldaña, 2009) then occurred to compare our initial interpretations of the data. This process was repeated this process for the first ten transcripts. The remaining transcripts were then divided equally between the undergraduate researcher and me to code. From this analysis, an initial version of the codebook was produced and reviewed by my dissertation advisor. The data were then reanalyzed by the undergraduate research assistant and I based on feedback from my advisor and the codebook was iteratively revised through consensus building (Saldaña, 2009). Data were simultaneously coded if they were reflective of more than one code (Saldaña, 2009). The final version of the codebook was reviewed by my dissertation advisor.

2.4.5.2 Systems Maps

The domains and sub-factors of the PWS do not exist in isolation and are shaped by dynamic systems that produce interacting relationships between and among the high-level domains and sub-factors. Systems mapping was used to identify these interactions (Gillen et al., 2014; Sedlacko et al., 2014). The final version of the codebook, with the deductively derived domains and inductively derived sub-factors, was transferred into a graphical depiction of an enhanced PWS using Miro, an online visual collaboration platform (Miro, 2023). For each participant, quotations relevant to each sub-factor were distilled into short 5-10 word summaries on “sticky notes” in Miro. These “sticky notes” were then placed into the relevant

sub-factor “box” in the enhanced PWS. Using a deductive approach, interactions between sub-factors were categorized as facilitative or inhibitory. Inductive approaches were used if an interaction had other characteristics. Lines were drawn between and among sub-factors and outcomes to represent interactions. Different line types and colors signified the types of interactions. A systems maps was created for each participant. Participants were then contacted via email to schedule a Zoom meeting or phone call to member check our interpretations of the data (Lincoln & Guba, 1985). Participants were contacted two times before they were considered lost to follow up. During the member checking sessions, participants were reminded of the purpose of the study and the topic content of the interview. An overview of the themes and sub-themes derived from the interview was provided. Then, each interaction was explained to the participant. Participants were asked to confirm or edit each interaction and if anything was missing from the map. Each systems map was updated accordingly. A consolidated systems map was created to represent all the relationships that participants mentioned between and among sub-factors and outcomes.

2.5 Phase Two: Interviews and Systems Mapping with Birthing Persons

2.5.1 Sample

To be eligible for the study, an individual must have been currently pregnant or pregnant within the last five years, reside in the Greater Richmond region, have low-income (this was determined by community partners to be an income less than 185% of the 2022 federal poverty level, which is the income eligibility criteria for the Womens, Infants, and Childrens Program in Virginia (Virginia Department of Health, 2022)), hold one or more racial or ethnic minoritized identities, and be 18 years of age or older.

2.5.2 Setting

Data collection took place remotely on Zoom or over the phone.

2.5.3 Recruitment

Participants were recruited mainly through members of the Greater Richmond Maternal Health Collective Impact Taskforce. Members shared information about the study with their

clients by posting on social media and/or posting flyers in their office spaces (Appendix A Exhibit A4). Additional recruitment took place by attending local community events and passing out flyers. Lastly, information about the study was posted on social media groups on Facebook specifically focused on parenthood in the Richmond region. Moderators of both public and private groups were contacted to ask permission to post information about the study. If permission was obtained, the research team posted information about the study.

Those who were interested in participating in an interview could fill out an eligibility survey on Qualtrics or contact the study team via email, phone, or text to assess eligibility. If eligibility criteria were met, potential participants were asked additional questions about demographic information through the same survey. The full eligibility survey is available in Appendix A Exhibit A5. Interviews were scheduled after the survey was completed by contacting potential participants via the preferred contact method stated in the recruitment survey. Participants were contacted two times before they were considered loss to follow up. Since the interviews were conducted remotely, it was difficult to determine potential repeat participants under different aliases. Based on criteria determined in consultation with the IRB, any strongly suspected repeat interviews were removed from the data set.

2.5.4 Data Collection

Interviews were semi-structured in nature. The interview guide was grounded in the domains of the patient work system as described above. A draft of the interview guide was created by the undergraduate research assistant and me and was informed by the data collected in Phase One. This draft was reviewed by my dissertation advisor. The full interview guide is available in the Appendix A Exhibit A6. Informed consent was obtained prior to starting the interview. Interviews lasted approximately 45 minutes to one hour. Participants received a $25 gift card as compensation for their time. Consent and the interviews were audio recorded and professionally transcribed.

2.5.5 Data Analysis

2.5.5.1 Interviews

Data were coded using both deductive (i.e. the high-level domains of the consolidated PWS model) and inductive approaches (Hsieh & Shannon, 2005). Data were analyzed using QSR NVIVO (QSR International, 2023). The first transcript was independently coded by both the undergraduate research assistant and me. Consensus building (Saldaña, 2009) then occurred to compare our initial interpretations of the data. This process was repeated this process for the first ten transcripts. The remaining transcripts were then divided equally between the undergraduate researcher and me to code. From this analysis, an initial version of the codebook was produced and reviewed by my dissertation advisor. The data were then reanalyzed by the undergraduate research assistant and I based on feedback from my advisor and the codebook was iteratively revised through consensus building (Saldaña, 2009). Data were simultaneously coded if they were reflective of more than one code (Saldaña, 2009). The final version of the codebook was reviewed by my dissertation advisor.

2.5.5.2 Systems Mapping

The approach for systems mapping was adapted for this sample to take place during the interview session as there was high potential for lost to follow-up with member checking. This conclusion was deduced from conversations with community partners as well as information garnered from the interviews conducted in Phase One. Two researchers were present during each interview. While one researcher was conducting the interview, the other was creating the systems map. The enhanced patient work system created in Phase One was used as a base map. For each participant, quotations relevant to each sub-factor were distilled into short 5-10 word summaries on “sticky notes” in Miro. These “sticky notes” were then placed into the relevant sub-factor “box” in the enhanced patient work system. Using a deductive approach, interactions between sub-factors were categorized as facilitative or inhibitory. Inductive approaches were used if an interaction had other characteristics. Lines were drawn between and among sub-factors and outcomes to represent interactions. Different line types and colors signified the types of interactions. Once all questions from the interview guide were asked, the

systems map was shared with the participant via screen share, text, or email during the interview session. Statement categorization into the respective sub-factor theme and interaction types were reviewed with the participant. The two researchers debriefed after every interview to discuss if any data was reflective of new sub-factor or new interaction type. The base systems map was updated accordingly through this iterative process for the remaining interviews. A consolidated systems map was created to represent all the relationships that participants mentioned between and among sub-factors.

2.6 Establishing Trustworthiness

There are four criteria of establishing rigor in interpretive work: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). These criteria are analogous to internal validity, external validity, reliability, and objectivity in quantitative research. Each of the criteria used to establish trustworthiness in qualitative inquiry and the associated approaches used in this research are listed in Appendix A Table A1.

Chapter 3 Results from Interviews and Systems Mapping with Health Care and Human Services Professionals

3.1 Sample Characteristics

Three individuals filled out the recruitment survey. In total, sixty-one individuals were contacted to participate in an interview. Twenty participants completed an interview. The demographic composition and organization information of the sample is available in Appendix B Table B1. The age ranges of the participants varied, with six being 25-34 years of age, eight 35-44 years of age, two 45-54 years of age, three 55-64 years of age, and one over the age of 65. Two participants identified as Hispanic or Latinx. Eleven participants identified as Black or African American and nine participants identified as White. A majority of the sample identified as cisgender female, with one participant identifying as cisgender male. Seventeen participants identified as straight, one as bisexual, and two chose not to disclose their sexual orientation. Participants worked for organizations that offered services across the Greater Richmond region, with a majority operating in the East End (n=8) and Southside (n=6). These organizations all served low-income populations, with 19 serving Black or African American populations, 18 serving Hispanic or Latinx population, 16 non-English speaking populations, and one serving LGBTQ+ populations. Services are offered across the maternal care continuum from preconception to postpartum care, with two organizations providing early childhood care. Most organizations offered lactation support (n=12), with nine offering financial support, five food access support, four doula services, four midwife services, three resource referrals, one education, one home visitation, one mental health services, one nutrition education, and one primary care. Fifteen organizations were supported through government grants, nine through private organizations, and seven through individual donors. Eleven accepted government-sponsored health insurance, eight accepted out of pocket payment from individuals, and five accepted private health insurance. A majority (n=15) of organizations had been operating for more than 10 years, with three operating for 6-10 years, one for 3-5 years, and one for 0-2 years.

3.2 Interviews

3.2.1 Overview of Themes

Twenty-seven secondary themes and 15 tertiary themes were derived inductively under the seven deductive themes of the patient work system framework. All themes relate to the primary task of accessing transportation to and from maternal health services. A full codebook is available in Appendix B Table B2. A depiction of the enhanced patient work system is available in Appendix B Figure B1.

3.2.2 Person

Attributes specific to an individual, namely biomedical characteristics, primary language spoken and socioeconomic factors, were reported by participants to affect transportation access.

3.2.2.1 Biomedical Characteristics

Participants primarily described how mental health conditions influenced transportation access. Participants mostly spoke about how depression and anxiety made it more difficult and at times impossible for their clients to plan transportation: "*There's many services that can be helpful to a person during the perinatal time, but the stress of having to orchestrate it when you're experiencing depression or anxiety is completely overwhelming, and folks will often not take those extra—the steps that they need to take or it's just impossible to take them, even if you had all of the gumption in the world. It's almost impossible."* (P11) [cross coded with tasks: difficulty]. One participant's organization helped to arrange transportation for those with cognitive impairments: *"My social worker will sometimes even three-way call them [Medicaid transportation] with the patient on the phone, because if the patient maybe had trouble—you know, a lot of our patients have cognitive impairment.."* (P9) [cross coded with tools and technology: communication technologies].

3.2.2.2 Primary Language Spoken

Participants felt that if the dominant language used by an individual was not English, that transportation was harder to access. One participant explained that the public bus system

was harder to navigate: *"language can sometimes be a barrier...[to] understanding the bus system...understanding the number system and which buses drop off in this location...understanding how to access that information, and being able to use it, understanding how to pay for the bus system, how to get a card.."* (P15) [cross coded with tools and technology: public bus]. Another participant found that transportation services were harder to schedule for those that did not speak English or Spanish: *"I've noticed if they're not speaking Spanish or English, it is more difficult for them to schedule the appointment for transportation on their own. In those cases, I try to help them utilizing our translation services to call."* (P20) [cross coded with tools and technology: non-emergency medical transportation]. In another case, a participant expressed that non-English speaking clients had a harder time understanding which clinic service locations were closest to where they live: "*The geography of the area is challenging. Just asking a patient where they live in relation to other things, they may not know the answer. When I ask them, "What clinic would you prefer to be seen at," they just say, "I don't know," or, "whichever clinic."* (P19).

3.2.2.3 Socioeconomic Factors

Participants reported that their clients who had limited income experienced difficulties paying for transportation. One participant spoke about how affording gas was difficult: *"I know that, sometimes, gas—if we talk about individuals who don't have a lotta resources having to find the money for gas can be really tough."* (P17) [cross coded with tools and technology: car]. Participants noted that their clients had other financial demands that affected being able to afford transportation: *"[transportation] can be expensive, but for someone who doesn't have stable housing, they don't know where they're going to live from day to day or there's a food scarcity going on or other issues in the home that mandate that finance would be more of a priority, it gets really difficult."* (P1)

3.2.3 Tasks

Characteristics of the work that participants expressed that their clients needed to complete included coordination, difficulty, and frequency.

3.2.3.1 Coordination

Participants described the ways in which they assisted in organizing transportation with their clients. One participant worked with their client to schedule transportation: *"The coordination piece of that, once we knew what the need was, the program participant voiced their need, and we knew what it was, we were able to talk to her, text her, email her, and be able to arrange for that transportation and that service to occur the following week at a certain day and time."* (P1). [cross coded with tools and technology: communication technologies]. Another participant described helping a client coordinate around the schedule of the person that could give their client a ride: *"If your ride works—most of the appointments are during Monday through Friday, normal working hours, bein' able to coordinate and make those shifts would be a lotta the conversation that we would have in terms of, "Hey, this appointment is at this time." Also, sometimes working with them to shift an appointment if they say, "Hey, my ride is only available on this day," so coordinating with them."* (P20) [cross coded with social environment: personal network: direct transportation access].

3.2.3.2 Difficulty

Participants detailed the efforts required for their clients to access services. One participant noted the difficulties of transporting infants: *"Just thinking about what it takes to—we try to make sure too that people have strollers, but sometimes, we don't know that they don't have a stroller, and then they're lugging a car seat around. That's impossible around this—the hospital. Yeah. Thinking about that too. If you do take the bus, you're bringing the car seat, the stroller, your bag, all of these things that you're carrying just to get here for an appointment. That is just not realistic."* (P18) [cross coded with tools and technology: infant transport items; outcomes effects of exertion: physical]. Participants reported that it is increasingly challenging for their clients who do not speak English to schedule transportation and navigate the bus system (see person: primary language spoken).

3.2.3.3 Frequency

Participants mentioned that the number of times a task needs to be completed affected whether their clients could access transportation. For those with high-risk pregnancies, a

participant stated that their clients could not afford to go to multiple appointments a week: *"...the higher risk the pregnancy, the more appointments that these people require. A lotta people forego goin' to certain appointments because they can either afford one bus ride a week versus we might be tellin' them they need two appointments a week or three appointments a week."* [cross coded with person: socioeconomic status]. One participant noted that their clients have to take multiple trips to the grocery store if walking is their primary form of transportation: *"I think the clients who are walkin', unfortunately, are probably doin' a lot of return visits to the store because they can only carry so much home. They're goin' to the store more frequently usin' their WIC if they can't get a ride or they don't have transportation because they just can't transport that much groceries at one time."* (P3) [cross coded with physical environment: built environment: location of stores].

3.2.4 Tools and Technology

Participants commented on the various devices, software, and hardware that they or their clients used for transportation access.

3.2.4.1 Car

Participants described instances where their clients used personal vehicles to access services. Though some of their clients has access to cars, one participant emphasized that the car was not always available: *"There's so many dynamics going on in families' lives and even though some of them do have own cars or have access to a car, it's still limited, or the car isn't well maintained and so it works today, but next week it's down, and it's not operable."* (P1). Another participant talked about the distribution of services around the area and the need to have a car to be able to access them: *"You don't have options for finding all of the services that you would need for maintaining a pregnancy and a healthy postpartum on one side of town. There's nowhere in the city where you could live and get all of those things. You have to have a car. You have to have reliable transportation. It's a major impact on healthy pregnancies."* (P10) [cross coded with location of clinical and social services].

3.2.4.2 Infant Transport Items

The devices used to transport children both helped and hindered transportation access. Participants described the difficulties with riding the public bus with a stroller: *"If an individual's pushin' a stroller, tryin' to navigate getting the stroller on a bus, that's a challenge."* (P2) [cross coded with tasks: difficulty; tools and technology: public bus]. To mitigate this challenge, a participant described educating their clients about baby wearing: "We do say that to moms who use public transit. 'You don't have to carry a stroller or a car seat if you're getting on a bus. You could put your baby in the sling or a baby carrier, and that would make it easier for you.'" (P2) [cross coded with tools and technology: public bus]. Another participant underscored the need for their clients to have infant transport items to access transportation: *"...they don't have a car seat, and they're post-partum. They're like, "I have a ride, but I don't have a car seat, right, for my baby."* (P9)

3.2.4.3 Communication Technologies

Participants mentioned using several tools to send and receive information to and from their clients. Though their clients owned phones, one participant emphasized that they cannot always afford the service: *"A lot of the people that we do see sometimes don't have the luxury of having either minutes on their phones or things like that, so we just go kinda like the longwinded, give them a phone call, voicemail kinda thing."* (P6) [cross coded with person: socioeconomic status]. Participants commented on the use of technologies to deliver services virtually. One participant used Zoom to facilitate support groups, though noted that this platform may be inaccessible for some of their clients: *"Zoom, to me, it feels more accessible for support groups. I also understand that not everybody has access to a computer. Not everybody has access to internet. Not everybody has a computer, phone, internet or knows how to work technology in the way that I do."* (P10) [person: socioeconomic status]. Another participant used virtual platforms to connect with clients that were not able to come in for a visit: *"...we do try to see if we can reach out to every patient that did not come into that visit or see if we can adjust their visit to something that is a virtual visit if that works better for them to make sure that we're keepin' in touch and touchin' base with everyone that might need immediate care."* (P14).

3.2.4.4 Non-Emergency Medical Transportation

Participants stated that their clients used services sponsored through health insurance to get to clinical appointments. Though participants expressed that accessing this form of transportation posed a lot of barriers for their clients (see organizational environment: operational dysfunction; organizational environment: policy: Medicaid transportation). One participant emphasized that the policies were hard for their clients to plan around: *"A lot of the patients have Medicaid transportation. However, they do not utilize it as a lot of times in addiction, you're not able to plan. You're planning things up to the minute. You don't see things further out, which also can be a barrier because with Medicaid transportation you have to set up your Medicaid three days in advance."* (P12) [cross coded with person: biomedical characteristics; organizational environment: policy: Medicaid transportation].

3.2.4.5 Public Bus

Participants expressed that their clients were frequent users of transportation managed on schedules and fixed routes: *"I would say buses would be a majority of some of my patient—I work at two different sites. At my downtown site, a lotta patients would use buses..."* (P14). Since the local bus system was not charging fares during the COVID-19 pandemic, participants felt that this alleviated financial barriers for their clients: *"I know people come by [public bus service]. I know that, right now, the fare continues to be of no cost. That's kinda been a big, I think, reduction in the barrier for some of our clients."* (P17) [cross coded with person: socioeconomic factors; organizational environment: policy: funding].

3.2.4.6 Rideshare Services

When funding is available, participants reported that they could pay for private transportation for their clients: *"We're able to get—we can get Lyfts for people, so that's something that we do often."* (P18) [cross code with organizational environment: policy: funding]. However, one participant noted that this funding was limited to clients seeking obstetric care: *"...give them social work assistance with credits towards usin' Uber or Lyft of something like that to come in to their visits. I don't think that that is something that's offered*

to non-obstetric patients so can definitely limit the care after pregnancy." (P14) [cross coded with organizational environment: policy: funding].

3.2.5 Organizational Environment

Participants reported that the following organized activities, entities, structures, and policies affected transportation access: household and community settings, operational dysfunction, and policy.

3.2.5.1 Household and Community Settings

Participants talked about offering services in direct or close proximity to their clients. One participant recounted taking items to their clients' homes: *"If they need a car seat or a stroller, baby clothes, nursing items. I'll take people breast pads and milk storage bags. If we get people—like if they need help paying for rent or groceries. Really, anything. Anything that they need that is within our budget, we're able to get and take to them. Yeah. We can go grocery shopping for people or with people. School supplies. Back-to-school shopping. Diapers. Diapers, wipes."* (P18). Another participant described offering home-based primary care: *"A lot of our community services boards now do primary care screenings. Some of them do have an in-home, in-house services where they do have a primary care provider, where you can do a one stop shop for everything, you don't have to constantly juggle different locations and transportation to different places."* (P6). Participants also met with clients in public spaces: *"It could be a library...Because of COVID, we've done park. We've got public parks. We've done schoolyards and playgrounds."* (P1).

3.2.5.2 Operational Dysfunction

Participants conveyed that their clients experienced problems with organizations not operating within the stated policies and procedures. Participants felt that Medicaid transportation was not reliable: *"It makes it seem like we are giving false hope to patients. I can say don't worry, use your Medicaid transport. You'll get here. Transportation is set up. The patient is up, ready for the appointment, Medicaid transport does not show. This is not a trustworthy process, and then it just overall affects—I have this insurance and I can't really use it the way that I need to. There is a lot of benefits that the patient is supposed to get with their*

insurance, especially Medicaid, and they don't really get to utilize them like that." (P12) [cross coded with tools and technology: non-emergency medical transportation]. One participant expressed that their clients may face repercussions for operational dysfunction that is out of their control: *"...they're reliant on Medicaid transportation, and we know how unreliable that transportation is for timeliness, then we're just punishing the pregnant person [for not accessing care]."* (P16).

3.2.5.3 Policy

Formalized rules affected transportation access across the following areas: bringing children to clinical appointments, bus routes, bus use, funding, Medicaid transportation, running late to clinical appointments, WIC benefits, and work leave.

3.2.5.3.1 Bringing Children to Clinical Appointments

Participants stated that their organizations had varying policies on whether children could accompany their clients. One participant commented that their transportation and childcare program located at their site helped to increase access to services: *"Their numbers and the actual access to treatment in those particular [community services board] went up astronomically, just because they didn't have to worry about the next appointment and how they were gonna get there or who can watch the kids. It was just very easy and accessible to them."* (P6). Though another participant's organization had a similar transportation program, they mentioned that they were not allowed to transport families: *"No, 'cause one of the requirements is that staff have to have a car and that it works, and that its operational. That's part of what you need to have to be employed, and we reimburse mileage, but we don't transport families."* (P8)

3.2.5.3.2 Bus Routes

Participants conveyed that the set course and frequency of the public bus affected their clients being able to not only access services but also accessing them in a timely manner. One participant talked about how the bus system does not go to certain clinical locations: *"...the busses, but they still don't really extensively go out into the counties...and honestly, and we have two other outpatient sites that offer prenatal care, no bus transportation...You have to*

figure that out yourself, which is an implication, too, from the healthcare system that they—it looks like we don't want Medicaid patients at those more higher-end outpatient clinics." (P16) [cross coded with tools and technology: public bus; physical environment: built environment: location of clinical and social services]. Another participant commented on how much time it takes to ride the bus to access services: *"Oftentimes our patients are taking off from work to get to an appointment. It's interesting that they spend so much time trying to get to their appointment, taking time off of work, and oftentimes our appointments are very quick...when you're kind of deciding whether it's, it's important to come to this appointment, the appointments are 15, 20 minutes, but you spent three, four hours, just trying to get to a 20 minute appointment, I can see how simple patient's might decide that in their mind, it's not worth it to go through all this trouble for a 20 minute appointment."* (P15) [cross coded with tools and technology: public bus; outcomes: missed and delayed medical care; outcomes: taking time off of work].

3.2.5.3.3 Bus Use

One participant described a scenario where their client was not allowed to get on the bus with a stroller: *"the program participant, the mom, continued to tell the bus driver that she couldn't fold the stroller any more than what she did. It does collapse, but apparently, it didn't collapse in the way that they're accustomed, so the driver who obviously was following their protocol said, 'I can't have you on the bus because this has to fold in a better manner.'...Anyway, it escalated and the program participant, the mom, had the driver contact the supervisor of and I think the supervisor, to my understanding, continued to follow protocol as well. The young lady was not allowed to ride the bus. She was trying to get to a doctor's appointment."* (P1) [cross coded with tools and technology: infant transport items].

3.2.5.3.4 Funding

Participants detailed multiple ways in financial aid for transportation increased access to their services. One participant's organization was able to purchase rideshare vouchers and bus passes: *"Well, when it's well-funded, we have a lot of flexibility to purchase things, like Ubers or passes or the different things that clients need."* (P11) [cross coded with tools and technology:

rideshare services]. Participants experienced that this type of funding in some cases only covered their clients when they were pregnant: *"unfortunately with all grants they come with a very strict criteria of who falls under that category, how long a patient can be in that category, so we might be fundin' this patient until they're no longer pregnant, but that doesn't take away the fact that they still need this access to foods, et cetera, particularly when they get in the postpartum period."* (P14). One participant also described the limits on the number of times their clients could use transportation vouchers: *"Now, because the young lady went to see her baby every day [in the hospital], we would not be able to offer her every day, but within reason, we probably could have reasonably provided her twice a week rides down to the hospital for at least the next few weeks until the baby progressed and got discharged from the hospital."* (P1) [cross codes with tasks: frequency]. Participants emphasized that this type of funding was temporary: *"Because the word is throughout the community that they know that most of these programs either do not provide the transportation or cannot provide the transportation any longer because of limited resources."* (P1).

3.2.5.3.5 Medicaid Transportation

Participants reported that the policies surrounding transportation sponsored by government health insurance created barriers for their clients. Participants commented on the scheduling policy, where their clients could not receive transportation unless they scheduled it three days in advance: *"Medicaid to make sure if there's anything else we can do or if there's any exceptions to the rules. Could we call within two days because sometimes, a patient will call in crisis and say I need to get an appointment today or tomorrow. They can get the appointment, but the transportation is the issue. The reason why we can't do the transportation, 'cause Medicaid guidelines say it has to be a three day notice."* (P12) [cross coded with tools and technology: non-emergency medical transportation]. One participant attempted to coordinate transportation for their client, but was not allowed to do to policy: *"They have a policy where the patient has to call and make their transportation appointment. We can't call for them. Like I mentioned before, with all those barriers our patients face, they just don't do that sometimes. We wanna take that—we have the staff and the support to do that, right, 'cause we have our special program. We have the staff who could do that for them*

when needed, but they don't even allow us to. Because, again, the system's not made for people with all these extra barriers. It's a small thing, but that does impact us." (P9) [cross coded with tools and technology: non-emergency medical transportation]. Another participant stated that their clients used to take Medicaid transportation to WIC clinics, however, new policies no longer allowed for this: *"Years ago, there was funding through the district where we could give clients bus tickets for WIC visits, but that is no longer, and then unfortunately, Medicaid used to count WIC as a medical visit, and they would provide transportation."* (P3) [cross coded with tools and technology: non-emergency medical transportation].

3.2.5.3.6 Running Late to Clinical Appointments

Participant's organizations had differing policies related to clients arriving after their set appointment time. One participant mentioned that their organization must see obstetric patients on the day of their appointment, no matter how late they are: *"...if they end up missin' a bus, that might mean they're 30 minutes, an hour late to an appointment. Then it becomes our system of how we work these patients in. We have a policy right now that we would always work in an obstetric patient, regardless of the timing of when they came or did not come. I think that's been workin' pretty well."* (P14) [cross coded with tools and technology: public bus]. However, another participant explained that their clients might have to wait multiple hours to be seen: *"One policy that they did enact, which a lotta providers have some issue with is that if you are pregnant, and let's say you're late. Let's say you're even an hour late for your appointment. You cannot be turned away. Maybe that means that you're then gonna be seen at the end of the clinic day. Maybe you had an appointment at 1:40, and you got there at 2:40. Well, we can't see you until 3:40 or 4:00 because everybody's booked until that time. We cannot policy wise turn you away anymore. We can't say, "Sorry, you gotta reschedule."* (P16).

3.2.5.3.7 WIC Benefits

During the COVID-19 pandemic, policies allowed WIC services to be offered remotely. Participants experienced increases in enrollment and retention due to this policy since their clients did not have to travel to WIC clinic locations: *"Absolutely, our caseload has increased significantly. The compliance level of spending the benefits has increased, and I think it's all*

because they don't have to physically come in. We are reaching more people because we're getting them durin' the day, at home. They don't have to come into the clinic. If they can't talk right then, they're callin' us back when it's convenient for them. We're reaching more people because not havin' to get that transportation is just makin' it so much easier." (P3) [outcomes: retention]. A participant who was trying to coordinate with WIC to ensure their client received benefits stated that they were not able to serve as a proxy for their client over the phone: *"WIC for me as a clinician has a really big barrier which it shouldn't be when you're trying to help people that are pregnant. Things have changed during COVID, so during COVID WIC, they weren't doing any in-person intakes. They would just call in the patient, but the problem with that is a lot of our patients, they don't keep their phone on. I call WIC just to make sure that we can work something out or when the patient comes to their appointment, they can use my phone and they can do their intake. WIC has made it really hard for us because they won't—now they have started to say that they won't talk to us which is—that's so unheard of because we've been doing this for years. We send the referrals to WIC, so that has become a barrier for them."* (P12).

3.2.5.3.8 Work Leave

Participants described situations where their clients could not take the amount of time off of work needed to access transportation to services: *"The higher risk patient requires now more care in this pregnancy that they can't always be compliant with. We talk a lot about patients not being compliant with what you're recommendin', but sometimes it's puttin' them in a rock and a hard place, where if you miss more days you're gonna lose your job, and then that starts a cycle of something that is unforgiveable."* (P14).

3.2.6 Physical Environment

The external conditions, namely the built and environment and weather, were reported by participants to influence transportation access.

3.2.6.1 Built Environment

Participants talked about the availability and condition of the following structures and systems: location of bus stops, location of clinical services, location of stores, parking, and pedestrian infrastructure.

3.2.6.1.1 Location of Bus Stops

Few participants mentioned determined points for public transit passenger pick up and drop off. Of those who did, they noted that it was harder for their clients to access transportation if they lived far away from a bus stop: *"...a couple patients that have actually missed numerous OB visits because of their inability to get a ride to the closest bus stop, which would've gotten them to their appointments."* (P14).

3.2.6.1.2 Location of Clinical and Social Services

Participants noted that the placement of organizations that provide health related services effected whether participants could access services. One participant discussed that their clients struggled with getting transportation access to WIC clinics: *"They just go without anything if they can't get transportation. They'll lose that whole month of benefits by not getting that appointment in-person."* (P3) [cross coded with organizational environment: policy: WIC Benefits]. Another participant emphasized the importance of being able to access pharmacies: *"That [high blood pressure] is very common after pregnancy. If you can't get to your medications because your pharmacy isn't close to your house or not in walking distance."* (P10). A participant whose organization offered services near their clients felt that it more accessible for their clients to attend educational classes: *"I'm also thinkin' that we offer car seat classes there too. Individuals, if they need to come pick up a car seat, do the trainin' to pick up a car seat there, they're usually able to make it to us, with some effort, but they're usually able to make to us to access those services."* (P2) [cross coded with organizational environment: household and community settings].

3.2.6.1.3 Location of Stores

Participants discussed the importance of their clients being able to access retail establishments that sell healthy foods and infant care items. One participant noted in particular issues with their clients accessing formula: *"If you can't find formula for your child. If formula is on the other side of town and not on your side of town. You don't have access to go get that formula in a time that you need it. Then you're possibly looking at making your own formula or stretching your formula. Which then puts your baby's health at risk."* (P10). Another participant reflected on the lack of availability of food in the neighborhood in which their clients live: *"...a lot of our patients that live near the [neighborhood] location kind of stay in food desert area where there's not really quality food close by."* (P20).

3.2.6.1.4 Parking

Participants emphasized the need for places where clients could leave a vehicle. A participant described that the parking situation at their organization hindered access: *"This particular program was put in the middle of the downtown district where there is no parking, and it was very counterproductive both for the, what you say clients, or we call them program participants, to come to the office for anything that we needed them to come through to access there.... We're...on a side street, with the bus coming down. There's no way for anyone even pull up in front of the building or even on the side of the building for even two minutes. It was just not something that was permitted to do."* (P1). Participants described their organization moving to a new location with better parking: *"Prior to our new move, we used to be in a different building. Parking was an issue. Even though they got here in time, it was hard to find parking. That has been fixed, or I don't see that as often because of the new parking situation."* (P15)

3.2.6.1.5 Pedestrian Infrastructure

Participants did not talk much about the conditions of physical structures for activities such as walking, using a wheelchair, pushing a stroller, etc. If these structures were mentioned, participants reported that they were beneficial for their clients: *"In both places, there's a long sidewalk so you can just get off the bus and go straight to the clinic on both sites."* (P12) [cross coded with tools and technology: public bus].

3.2.6.2 Weather

Participants discussed that adverse conditions outside served as barrier for their clients as it was harder and sometimes impossible to access transportation. For one participant, their client walked to meet them in the heat: *"Once she got there because she was pregnant and because of the hot weather and because she has two little ones under two and a half, she definitely needed a breather. You could tell it was a little bit uncomfortable for her."* (P1) [cross coded with effects of exertion: physical].

3.2.7 Social Environment

Participants reported that their clients relied on other people for transportation access. These people were community members, peers, and personal network members.

3.2.7.1 Community Networks

One participant described that their clients received transportation from people living in the same geographic location through informal taxi drivers: *"We do see, again, a lot of clients who use ride sharing—not the Uber, but their traditional taxi men from the community."* (P5).

3.2.7.2 Peer Networks

One participant talked about a program that provided transportation assistance from people who have similar experiences: *"Having this peer recovery specialist be the person to transport them, and also talk to them while they're in the van with them and waiting for appointments potentially, because they're had that lived experience with women's services."* (P6)

3.2.7.3 Personal Network

Participants mentioned that their clients receive transportation access from family and friends. Participants noted that personal network members provided rides with their personal vehicles: *"Those people, most of the time they have their own car. They have their own transportation or they have a partner like a husband or a significant other that really cares about them getting to the clinic."* (P12). Even if clients could receive assistance from their personal network, one participant noted that this method of transportation could be

uncomfortable for their clients seeking services related to substance use: *"...their partner, right, the father of their baby doesn't even know about it, and so if they ask them for a ride they're gonna wanna come in with them. Right? Maybe my patent isn't ready to talk to her family yet about getting her treatment for their substance use."* (P9).

3.2.8 Outcomes

Participants recounted the impacts accessing transportation had on their clients. These impacts included: accessing necessary items, being stranded, experiencing the effects of exertion, making financial tradeoffs, missing and delaying medical care, retaining clients, and taking time off of work.

3.2.8.1 Ability to Access Necessary Items

Participants explained that the location of stores in relation to where their clients lived affected access to food and infant care items (see physical environment: built environment: location of stores).

3.2.8.2 Being Stranded

Participants recalled situations when their clients could access transportation to their services, but could not access transportation back to where they lived. One participant recounted an instance where a personal network member could not pick up a client: *"Sometimes patients will come in, especially on labor and delivery, they'll come in for a triage visit, and they may have taken public transportation, but by the time that they're leaving, there's not reliable transportation for them to go home with. That could be a barrier. Sometimes they'll have friends who can drop them off, but then coming to pick them up might be an issue."* (P15) [cross coded with social environment: personal network]. Participants also described this situation happening with Medicaid transportation (see organizational environment: operational dysfunction].

3.2.8.3 Effects of Exertion

Participants detailed acute impacts that accessing transportation had on their clients' mental and physical health.

3.2.8.3.1 Mental

Participants discussed that their clients experienced increased stress accessing transportation: *"It's not that families do not want to access care or access quality care, but they have so many obstacles and adversities typically in their daily routines that it's really a challenge. It's not impossible, but it can be overbearing and overwhelming for families to be able to access care on a consistent and regular basis."* (P1). For participants whose clients were diagnosed with anxiety and depression, they conveyed that public transportation posed specific challenges: *"Bus transportation, I think, puts people in a really vulnerable state because you don't have the privacy to be in pain, right, and you're the only person that sees it or struggling with your mental health, anxiety, and depression. It can really be on display."* (P17) [cross coded with person: biomedical characteristics; tools and technology: public bus].

3.2.8.3.2 Physical

Participants commented on the various outcomes accessing transportation can have on their clients' bodies. Participants talked about the effects of using public transportation. For pregnant clients, they detailed the physical effects: *"There's no place to sit, and it's harder for pregnant women to stand for long periods of time. When you are pregnant, you're blood volume increases. Those symptoms are pelvic weakness from the pressure of a baby pressing on all of your internal organs and joints and bones."* (P20) [cross coded with tools and technology: public bus]. For clients in the postpartum period, participants emphasized the physical challenges of attempting to access services: *"If they delivered by C-section, then they're also—so they come in for a one to two week visit and not a six week postpartum visit, so especially that one to two week visit it's really hard. It's really hard for a patient with lots of resources in a private vehicle to get there. Having to rely on public transportation adds a whole other layer of challenge."* (P19) [cross coded with tools and technology: public bus].

3.2.8.4 Financial Tradeoff

Participants underscored the monetary sacrifices their clients had to make to pay for transportation: *"We talked about just food and rent and all those other things that it takes to live, honestly. I think a lotta times, our patients and clients, they do have to make a choice.*

Sometimes, getting to actual care is one of the ones that falls to the wayside." (P17) [cross coded with outcomes: missed and delayed medical care].

3.2.8.5 Missed and Delayed Medical Care

Participants expressed that their clients faced various challenges accessing transportation that resulted in the inability to access health-related services. One participant experienced that their client's personal network members could no longer provide a ride to services: *"Sometimes they'll [the client] call and say, "Hey. Sorry. Can't get ahold of this person who said they were gonna take me. I have to cancel or reschedule."* (P6) [cross coded with social environment: personal networks]. Participants conveyed that their client's would cancel appointments if they did not have childcare: *"Sometimes, people just think it's not worth it. I have my children with me. I'm not gonna take these children on the bus or the bus doesn't run, so I can't come to my appointment."* (P12).

3.2.8.6 Retention

Participants reported that transportation assistance and remote services increased the number of clients receiving consistent services. A participant stated that their retention rate increased once their organization started providing support for transportation: *"I can say that the rate of show for many of the patients and clients in accessing their medical care as well as other supportive services was higher when we eliminated the barrier—'cause it is a barrier—of the client having to get to the appointment themselves."* (P17) [cross coded with organizational environment: policy: funding]. Once WIC services were offered over the phone, participants noticed an increase in existing clients using their benefits and new clients enrolling in the program: *"If I think back to conversations that I've had directly with WIC, they saw their retention numbers and then also their initiation numbers increase when it was, "You don't have to come down here for an appointment. We can actually just do everything over the phone."* (P2) [cross coded with tools and technology: communication technologies; organizational environment: policy: WIC benefits].

3.2.8.7 Taking Time Off of Work

Participants recounted times when their clients had to significantly reduce their hours of employment due to the amount of time transportation to services took: *"You might have an appointment at 11:00 a.m. Seriously, they will pick you up at 8:15, drop you off at the clinic at let's say 9:00. Let's say magically you live 45 minutes away from the clinic. Drop you off at 9:00, and then you're basically, just there until your appointment starts at 11:00. It's just this overarching thing that if you use Medicaid, then you're getting free insurance, right, and so, therefore, you have to pay with your time. There's no free ride. You're gonna pay by havin' you take an entire day off from work."* (P16) [cross coded with tools and technology: non-emergency medical transportation; organizational environment: operational dysfunction].

3.3 Systems Mapping

3.3.1 Overview of Themes

Under the primary theme of interactions, one inductive additional secondary theme emerged. A codebook is available in Appendix B Table B3. The consolidated systems map graphically depicting interactions and workarounds embedded in the enhanced patient work system is available in Appendix B Figure B2.

3.3.2 Interactions

Participants discussed the combined effects of sub-factors as being facilitative and inhibitory in nature. Facilitative interactions were relationships between and among distinct sub-factors that resulted in improved transportation access as it relates to a distinct outcome. Inhibitory interactions were relationships between and among distinct sub-factors that resulted in disrupted transportation access as it relates to a distinct outcome. As some interactions had a dual nature (i.e. at times acted as facilitative and other times, inhibitory), they are discussed concurrently. Participants described the approaches they took to address inhibitory interactions by modifying work system sub-factors to influence outcomes, which are referred to workarounds.

3.3.2.1 Interactions within the Microergonomic Triad

Participants explained a various set of inhibitory interactions within the microergonomic person-task-tools triad. With regards to biomedical characteristics, participants talked about conditions like anxiety and depression that made it more difficult for their clients to coordinate transportation using the bus, non-emergency medical transportation, and rideshare services, resulting in the outcomes: effects of exertion and missed and delayed medical care: "*There's many services that can be helpful to a person during the perinatal time, but the stress of having to orchestrate it when you're experiencing depression or anxiety is completely overwhelming, and folks will often not take those extra—the steps that they need to take or it's just impossible to take them, even if you had all of the gumption in the world. It's almost impossible."* (P11). Participants noted that their clients who did not speak English also experienced task difficulties with coordination, leading to the same outcomes: *"we serve a lot of bilingual individuals, or individuals that don't speak English as a primary language. I've noticed if they're not speaking Spanish or English, it is more difficult for them to schedule the appointment for transportation on their own."* (P20). Participants reported using communication technologies, namely calling on the phone and using translation services, as workarounds to these inhibitory interactions, effecting the outcome: retention by coordinating transportation to maternal health services. Participants shared that socioeconomic factors served as inhibitory interactions with using a car, the bus, and rideshare services and purchasing infant transport items: *"it [transportation] can be expensive, but for someone who doesn't have stable housing, they don't know where they're going to live from day to day or there's a food scarcity going on or other issues in the home that mandate that finance would be more of a priority, it gets really difficult."* (P1). These interactions led to the following outcomes: financial tradeoff and missed and delayed medical care. There were no direct facilitative interactions noted by participants in the context of the sub-factors that exist within the micro-ergonomic triad.

3.3.2.2 Interactions Between and Among Microergonomic and Macroergonomic Factors

3.3.2.2.1 Organizational Environment

Participants shared that sub-factors within the organizational environment produced both inhibitory and facilitative interactions with sub-factors within the microergonomic triad. Participants talked about how policies that restricted bringing children to services increased the need for task coordination. If childcare arrangements fell through at the last minute, participants reported that it affected the outcome: missed and delayed medical care: "*Other reasons for it might be due to childcare, where they could have gone to the visit, but because they somehow don't have any more—don't have childcare, whether their kid was sick, whether they don't have a babysitter, whether they don't have someone to watch their children, that might affect the timing that they come to the visit, or reasons why they might have to cancel the visit."* (P15). Participants expressed that the Medicaid transportation scheduling policy requiring multiple days advanced notice further contributed with inhibitory interactions between person: biomedical characteristics and tasks: coordination and tasks: difficulty as described above: *"[transportation] can be a barrier because with Medicaid transportation you have to set up your Medicaid three days in advance. (P12).* Policies related to running late to clinical appointments served as both inhibitory and facilitative interactions with operational dysfunction and tools and technology: bus. Some participants reported that they could not see clients if they were more than 15 minutes late and others stated that they still had to see clients when they were pregnant no matter how late they were, this resulted in the outcome: missed and delayed medical care and outcome: retention, respectively: "*We have a policy right now that we would always work in an obstetric patient, regardless of the timing of when they came or did not come. I think that's been workin' pretty well."* (P14)".

With regards to workarounds, participants explained that their organizations provided vouchers or directly paid for transportation to address cost barriers for their clients: *"...[We] give them social work assistance with credits towards usin' Uber or Lyft of something like that to come in to their visit."* (P14). Cost barriers related to the sub-factor person: socio-economic factors and inhibitory interactions between the sub-factors tools and technology: public bus and tools and technology: rideshare services. The sub-factor organizational environment:

policy: funding served as a direct workaround to mitigate the following outcomes: financial tradeoff, missed and delayed medical care, and retention. Participants also mentioned adjusting their organization's operating schedule to align with the availability of their clients: *"...we knew that we were attracting a lot of working parents, we would hold the support group meetings at night."* (P11). Operating schedules were inhibitory interactions between person: socioeconomic status and organizational environment: policy: work leave. Changing the time services were offered was a direct workaround to mitigate the following outcomes: taking time off of work, missed and delayed medical care, and retention. Participants shared that they used various tools, devices, hardware, and software to provide services: *"I think the pandemic has significantly changed how we provide virtual care. Since I think that for that has opened up access to patients who may not be able to come in..."* (P15). Participants reported that providing services remotely reduced the need to access transportation, eliminating inhibitory interactions. Providing services remotely was a direct workaround to mitigate the following outcomes: missed and delayed medical care and retention.

3.3.2.2.2 Physical Environment

Participants experienced that their clients would cancel their appointments during bad weather if they used public transit, creating an inhibitory interaction between weather and tools and technology: public bus contributing to the outcome: missed and delayed medical care: *"Of course, bad weather makes people stay home, especially if you're using public transportation"* (P11). Participants reported that the location of bus stops served as inhibitory interactions with location of stores and location of clinical services and social services along with tools and technology: public bus as the presence of a bus stop near these services influenced the outcome: availability of necessary items and outcome: missed and delayed medical care, respectively: *"...a couple patients that have actually missed numerous OB visits because of their inability to get a ride to the closest bus stop, which would've gotten them to their appointments."* (P14). The location of bus stops also was discussed as a facilitative interaction with pedestrian infrastructure as the presence of structures like sidewalks to and from bus stops influenced the outcome: retention: *"In both places, there's a long sidewalk so you can just get off the bus and go straight to the clinic on both sites."* (P12). Participants

commented on the presence of parking at clinical and social services sites as both an inhibitory and facilitative interaction, influencing the outcomes: missed and delayed medical care and outcome: retention, respectively. As a workaround, one participant stated that their organization moved locations to improve their parking availability: *"Prior to our new move, we used to be in a different building. Parking was an issue. Even though they got here in time, it was hard to find parking. That has been fixed, or I don't see that as often because of the new parking situation."* (P15).

3.3.2.2.3 Physical Environment and Organizational Environment

Bus routes served as inhibitory interactions with tasks: difficulty and coordination as participants reported that their clients might have to take multiple buses to access clinical and social services. This interaction resulted in the following outcomes: missed and delayed medical care and taking time off of work: *"Oftentimes our patients are taking off from work to get to an appointment. It's interesting that they spend so much time trying to get to their appointment, taking time off of work, and oftentimes our appointments are very quick...when you're kind of deciding whether it's, it's important to come to this appointment, the appointments are 15, 20 minutes, but you spent three, four hours, just trying to get to a 20 minute appointment, I can see how simple patient's might decide that in their mind, it's not worth it to go through all this trouble for a 20 minute appointment."* (P15).

3.3.2.2.4 Social Environment

Participants reported that all of the sub-factors in the social environment at times served as facilitators. Community networks, peer networks, and personal networks at times interacted with tools and technology: car to provide rides to and from maternal health services: *"Some of them [clients] might live further away and require private transportation but from a family member because they themselves might not have access to their own car."* (P14). Taken together, these facilitators had casual relationships with outcomes: retention. Conversely, participants mentioned instances where personal networks served sometimes as an inhibitory interaction with tools and technology: car as they could drive them to appointments, but it was variable as to whether they could pick them up: "*Sometimes they'll have friends who can drop*

them off, but then coming to pick them up might be an issue." (P5). In these cases, these inhibitory interactions produced the following outcomes: being stranded and missed and delayed medical care.

Chapter 4 Results from Interviews and Systems Mapping with Birthing Persons

4.1 Sample Characteristics

A total of 55 individuals filled out the eligibility survey. Of these, 38 were eligible to participate and were contacted for an interview. Eighteen participants completed an interview. The demographic composition of the sample is available in Appendix C Table C1. All of the participants identified as Black or African American and three of those identified as Hispanic or Latinx. A majority of the sample identified as cisgender female (n=16) and straight (n=17), while two participants chose not to disclose their gender identity and one participant identified as lesbian. Two participants identified as disabled. Fourteen participants were in between 25-34 years of age, while 4 participants were in between 18-24 years of age. Participants lived in a wide range of geographic areas within the Richmond Area. Three participants were currently pregnant, six participants were pregnant within the last year, four were pregnant within the last two years, two within the last three years, one within the last four years, and two within the last five years. For two participants, this was their first pregnancy. Nine participants had one child, six had two children, and one had three children.

4.2 Interviews

4.2.1 Overview of Themes

Seven primary themes were derived from the deductive framework. Thirty-three secondary themes and 28 tertiary themes were derived inductively. All themes relate to the primary task of accessing transportation to and from maternal health services. A full codebook is available in Appendix C Table C2. A depiction of the enhanced patient work system is available in Appendix C Figure C1.

4.2.2 Person

Person-level factors pertained to the relationship between transportation access and characteristics specific to an individual. Participants reported that three person-level factors affected transportation access: biomedical characteristics, discomfort with rideshare services, and socioeconomic factors.

4.2.2.1 Biomedical Characteristics

Biomedical characteristics were medical conditions other than pregnancy that affected transportation access. One participant discussed how a medical condition affected their ability to drive. Consequently, they relied on transportation covered through Medicaid to get to appointments: "*I still have to make appointments through [transportation service] just because I'm not able or well enough to drive and am still very much unreliable.*" (P2) [cross coded with tools and technology: non-emergency medical transportation].

4.2.2.2 Discomfort with Rideshare Services

Though participants felt that rideshare services, like Lyft or Uber, were convenient, some participants had concerns about getting into a vehicle with a stranger. One participant shared that they were more comfortable on the bus for that reason: *"I have trust issues with every new person that comes across me, so I always prefer the bus because I think I feel like it's safer there."* (P9) [cross coded with tools and technology: public bus].

4.2.2.3 Experience of Pregnancy

Participants described how physiological changes during and after pregnancy affected their experience accessing transportation. For some participants, walking during pregnancy was challenging. As a result, the distance to a bus stop was too far to walk for one participant during their pregnancy, but was more manageable after pregnancy: *"I never walked that while I was pregnant. After pregnancy, I would say that it's peaceful. My baby liked when I walked around and stuff. That's peaceful for him and peaceful for me."* (P1) [cross code with physical environment: built environment: location of bus stops]. Participants had varying experiences after pregnancy having to transport their child. Though items like car seats and strollers made it easier to transport a child as opposed to carrying a child, participants described several challenges with using these items (see tools and technology: infant transport items).

4.2.2.4 Socioeconomic Factors

The amount of income a participant had access to influenced the types of transportation they used. Using a rideshare service was not financially feasible for some participants: *"Unfortunately my financial situation can't allow for that [taking Uber or Lyft]."* (P6). Though using a personal vehicle was preferable, participants found it challenging to pay for gas and maintenance: *"At times...I am financially low. I don't find it that necessary using the car 'cause I have to use a lot of fuel, which I prefer using the public [bus]."* (P5) [cross coded with tools and technology: public bus]. During the COVID-19 pandemic, the public bus did not charge a fare. However, if they had to pay for the bus, participants felt like they may be financially burdened: *"That [paying a bus fare] would've had affected me a lot because I only work at a car wash. I only make so much money. Yeah. Dealin' with the baby and stuff, that would've been too much."* (P1).

4.2.3 Tasks

There were multiple dimensions and characteristics of the work that needed to be completed to access transportation to maternal health services: coordination, difficulty, duration, frequency, and routinization.

4.2.3.1 Coordination

The level of organization needed to complete a task varied across participants. Organizing childcare and car usage were the main tasks that needed to be coordinated. Some participants had personal network members that could watch their children without advanced notice, while other participants had to coordinate schedules. One participant described the coordination process: *"I have to inform them [personal network member] quite earlier so that they can also check their availabilities and then they inform me whether they'll be available in that time and then I organize anything, provide for them everything that they need while I'm away..."* (P15) [cross coded with social environment: personal network: childcare]. Another participant was able to use their partner's car at times when they did not need it: *"I'm able to use it when he's not using it; maybe when he's not at work, but he doesn't have errands to run."*

(P10) [cross coded with tools and technology: car; social environment: personal networks: direct transportation assistance]. In addition to coordinating childcare and car usage, one participant also coordinated work schedules with their partner: *"Well, we have separate work schedules, but if he has to work overtime, he—I work 7 to 3, and he works from 4 to 12. We like the morning appointments 'cause that works for both of us. Yeah, we'll just meet at the care place, or if I don't work that day, then we'll just drive together."* (P3) [cross coded with tools and technology: car; social environment: personal network: direct transportation assistance].

4.2.3.2 Difficulty

The effort required to complete a task increased when participants had to use transportation methods other than a personal vehicle and bring their children with them. When taking a rideshare service, a participant discussed struggling with carrying their child and infant transport items: *"It ain't like somebody's gonna help me [when taking a rideshare service]...They don't really much help so it's a struggle. I have to struggle with baby, the car seat, the baby bags, and the stroller just to try to get in. It's just a struggle, it's pretty much really hard"* (P1) [cross coded with tools and technology: infant transport items; tools and technology: rideshare services; outcomes: effect of exertion: physical]. When another participant could not coordinate childcare, they had to bring their child with them on the bus to go shopping, making it harder to get all of the items they needed: *"It's so depressing because I just go and pick a few things and not [all] the things that I want."* (P11) [cross coded with tasks: coordination; tools and technology: public bus; built environment: location of stores; outcomes: effect of exertion: mental].

4.2.3.3 Duration

The amount of time it took to complete transportation-related tasks depended mainly on factors in the built environment. Some participants lived within walking distance of clinical and social services as well as bus stops. Living in close proximity to these locations provided some participants with options for modes of transportation: *"When my appointment is in the next one hour, and I have the time, I just walk. Yeah, when I'm not in a hurry, but when I have to be there, and I'm already late, I just take the bus, and it's less than five minutes."* (P18) [cross

coded with physical environment: built environment: location of clinical and social services; physical environment: built environment: location of bus stops]. For participants that lived further away from these locations, a one-way trip could take in between 40 minutes to an hour by bus, often times twice the duration of taking a car or rideshare service. One participant who took transportation services provided by Medicaid, typically had to wait a couple of hours to be picked up from a health services location: *"I have to wait three hours in order for them to come back to take me home even though the appointment was only set for 30 minutes."* (P2) [cross coded with tools and technology: non-emergency medical transportation].

4.2.3.4 Frequency

The number of times a task needs to be completed in a set period was variable. All participants visited health professionals multiple times throughout the course of their pregnancies. Participants with higher risks pregnancies needed to visits a health professional more frequently. Other tasks included going to the grocery store. One participant travelled twice a month with the assistance of a personal network member to redeem their government benefits at a store that was not accessible to them via bus: *"I go twice a month to do my WIC and go grocery shopping when I get my food stamps. My auntie will take me or whatnot."* (P1) [cross coded with built environment: location of stores; policy: bus routes; social environment: personal network: direct transportation assistance]. Another participant lived within walking distance of a grocery store and had to make multiple trips a week since they could not carry all of the items at one time: *"Well, it's stressful [going to the grocery store twice a week]. I wish I could have someone who could do groceries for me from time to time, but with the situation sometimes I just have to do it myself."* (P11) [cross coded with built environment: location of stores].

4.2.3.5 Routinization

The level of comfort with a task influenced where participants would go and the transportation mode they chose to take. One participant continued to seek clinical services at a location geographically far from their home because the clinic maintained continuity of quality care: *"I think it's just a routine like you're used to going somewhere, so you keep going there*

'cause you've gotten the best service since begun." (P17) [cross coded with physical environment: built environment: location of clinical and social services]. Another participant chose to walk to locations: "*Most of the time I walk because of the convenience [of] the routine..."* (P9). A participant who frequently used the bus no longer had to look up the schedule: "...*if I want to catch the early bus...I have to be at the bus stop by 5:30... If I miss it, there's another one that will come at 6:15."* (P14) [cross coded with organizational environment: policy: bus routes].

4.2.4 Tools and Technology

Participants used several different devices, hardware, and software to access transportation, including cars, infant transport items, the internet, non-emergency medical transportation, the public bus, rideshare services, and smartphones.

4.2.4.1 Car

Few participants owned their own personal vehicle. If participants had access to a car, it was most likely owned by someone in their personal network. In some cases, a participant's ability to drive was affected by their pregnancy: *"During my earlier pregnancy I used to drive myself, but later on my sister whom I live with used to drive me there."* (P11) [cross coded with social environment: personal network: direct transportation assistance]. For the participants who could access a car, they felt that it was quicker and required less effort than taking the bus: *"... it was much quicker, and I didn't have to walk to the bus stops. I didn't have to wait for the bus...It positively affected me because I didn't have to tire."* (P10) [cross coded with outcomes: effect of exertion: physical].

4.2.4.2 Infant Transport Items

Participants had both positive and negative experiences using tools to move a child from one place to another. For one participant who had to walk to the store, using a stroller helped alleviate the need to carry items: *"I don't carry 'em. I put 'em inside the—that's why I said I don't have no baby bags in there. Get the groceries inside the stroller under my son and walk."* (P1) [cross coded with physical environment: built environment: location of stores]. Having to

take a stroller on a bus induced stress for most participants: *"It's tiresome, [laughter] at times so annoying because getting to the bus stop, unfolding the stroller, or trying to have to ask for someone to help you carry the stroller inside, so it's very stressful."* (P9) [cross coded with outcomes: effect of exertion: mental]. Another participant's experienced both physical and mental health effects: *"Oh, it's stressful [getting on the bus with a stroller]. I've fallen down once."* (P12) [cross coded with outcomes: effect of exertion: physical; outcomes: effect of exertion: mental].

4.2.4.3 Internet

Participants accessed information online to plan transportation as well as to mitigate the need for transportation. One participant used a search engine to plan their route via bus: *"Okay, initially I used to just Google my destination. Yeah. Then I could just get to see the buses that make the day or the time. That is I'm just going to just go, and I know a particular time of it as I'm taking the bus."* (P17) [cross coded with public bus]. Another participant searched store inventories online to plan their shopping route: *"I am just checking the stores near me [online]...It was helpful because I was able to see if what I want is near me, or I had to go an extra mile for the things."* (P10) [cross coded with physical environment: built environment: location of stores]. As some participants preferred not to carry groceries, they used online ordering and delivery services: *"As long as I don't go out and carry stuff, I don't mind ordering, and they get delivered, so it's okay."* (P17).

4.2.4.4 Non-Emergency Medical Transportation

One participant used transportation services to clinical services provided through Medicaid. However, they found this mode of transportation to be inadequate: *"A lotta them [drivers] are inexperienced, unqualified, personally, to me, to be handling people that have health issues or have appointments regarding to their health...[they do] not care who they hire or make patients depend on. During the summer, while I was pregnant with—I was still pregnant with this child. Like I said, we missed my appointment."* (P2) [cross coded with organizational environment: operational dysfunction; outcomes: missed and delayed medical care].

4.2.4.5 Public Bus

A majority of participants took the public bus as either their primary or secondary means of transportation. Though most participants could access maternal health services by taking the bus, they often described difficulties with the experience. For one participant, the bus ride was uncomfortable when they were pregnant: *"I'll just go and take the bus, but most of the time I'll get uncomfortable because I'm pregnant..."* (P6). Another participant found it challenging to bring their children on the bus: *"...it was scary and overwhelming with the little ones...because I was worried how my children were gonna take...introducing them to a new type of thing, so it kind of sets you back."* (P9). [cross code with outcomes: effect of exertion: mental]. Taking the bus posed potential risks described by other themes (see social environment: strangers in public places; outcomes: assumed risks: exposure to infectious diseases; outcomes: assumed risk: threats to personal safety).

4.2.4.6 Rideshare Services

Participants expressed that using private transportation was easier than using public transportation. Using private transportation helped participants get to their appointments on time: *"Oh, booking on Uber is always very easier. It's easier. It helps me getting to the hospital much earlier enough, you know. You don't need to wait and wait to visit the doctor. I will just get to the hospital on time."* (P12). In one case, a participant preferred using rideshare over driving themselves in a personal vehicle: "*During my late pregnancies, I just shifted to taking an Uber every time 'cause I wasn't comfortable driving myself anymore. I wasn't able to do that."* (P15). However, using a rideshare service still posed difficulties for some participants (see tasks: difficulty). Using rideshare made it easier for participants to go grocery shopping but only if there was space available in the car to put shopping bags: *"When it comes down to goin' to the store, there are times where the Lyft people won't have space in their trunk, and they have to reject the ride because they didn't make space."* (P2). Overall, all participants found rideshare services to be expensive. For some, this amenity was completely unaffordable. For others, financial tradeoffs had to be considered (see outcomes: financial tradeoffs for more information).

4.2.4.7 Smartphone

For participants who owned smartphones, a few discussed their experience using a mobile app to find bus stops and track times. Being able to view the time schedule helped one participant get to the bus stop on time: *"It shows me the time schedule—the bus—when it will be passing by. With that, it helps me save a lot of time so that I get to the bus station by that time."* (P11) [cross coded with organizational environment: policy: bus routes; physical environment: built environment: location of bus stops]. Using the app helped another participant figure out what type of transportation they needed to use: *"Especially when I'm supposed to go somewhere and check in on the bus app, it used to indicate that the bus is way too far from where I was, so those are the incidences when I either had to contact my friend or use the personal car just in case my mom didn't leave with it."* (P5) [cross coded with tasks: coordination; organizational environment: policy: bus routes; physical environment: built environment: location of bus stops; social environment: personal network: direct transportation assistance].

4.2.5 Organizational Environment

Participants reported that transportation access was affected by organized activities, entities, structures, and policies including household and community-based services, operational dysfunction, policies, and scheduling systems.

4.2.5.1 Household and Community Settings

4.2.5.1.1 Midwifery Services

Two participants used midwives for in-home care. For one participant, the home-based care alleviated the physical burden of having to leave their house while pregnant: "*It was my first pregnancy, so I really was experiencing a lot of changes within my body, so I just preferred to stay inside the house."* (P11) [cross coded with outcomes: effects of exertion: physical]. In the post-partum period, home-based care eliminated the need to travel far for health services: *"Yeah, it [having a midwife come to their home] made a big, big difference 'cause..It helped a lot with not having to have driven that—drive that far [for 40 minutes]."* (P3).

4.2.5.1.2 Non-Profit Organizations

Organizations that provide charitable services assisted participants in accessing necessary items and resources. Several participants received deliveries of food and infant care items to their homes. Another participant was able to go to an organization located in their neighborhood that provided both food items but also mental health support: *"It [the organization] helps women with lots of stuff. Sometimes they call us and tell us that they have fruits, vegetables, grains. They have milk, so whoever wants or needs can just make a way there, get some. Yeah, sometimes they do counseling..."* (P18) [cross coded with physical environment: built environment: location of clinical and social services; outcomes: availability of necessary items: food availability].

4.2.5.2 Operational Dysfunction

When organizations, beyond health care systems, were not able to provide services in accordance with their stated policies and structures, participants emphasized the negative repercussions. One participant described feelings of panic when the bus was late: *"...the bus tends to delay. It just delays out of the blue. That wasn't what I was expecting. When the bus tends to delay, I have to delay, also, my appointment, the things that I was going to do. I tend to go late...I don't like delaying things. I feel as I'm going to delay something or I'm going to get late. Sometimes I panic out."* (P14) [cross coded with tasks: duration; outcomes: effect of exertion: mental]. When using transportation sponsored by Medicaid, a participant encountered multiple instances where they were not picked up even though they scheduled the service in advance: *"When it comes down to using...transportation through Medicaid, that's not guaranteed. The last three times, actually, that I've had transportation to my doctors' appointments, they didn't show up and had no explanation for it....the reason why I had to overcome my extreme fear of drivin' is because my OB was ready to drop me because of the missed appointments that came with the relying on transportation that came from my insurance."* (P2) [cross coded with tools and technology: non-emergency medical transportation; outcomes: missed and delayed medical care].

4.2.5.3 Policy

Participants described a range of policies across sectors that affected transportation access including policies surrounding bringing children to clinical appointments, bus routes, funding, mask mandates, Medicaid transportation, running late to clinical appointments, WIC benefits, and work leave.

4.2.5.3.1 Bringing Children to Clinical Appointments

Some of the health systems participants attended did not allow them to bring their children to appointments. This policy was due to protocols and procedures put in place to prevent the spread of the COVID-19 virus. One participant stated that they were able to bring their children with them to their midwife's office, but not their doctor's office. This participant experienced less stress when they were able to bring their children with them: *"I don't have to go take 'em to the daycare. Everything can just be done at once, and it's not any extra trips. They can both be with me, and it's not hard trying to pick one up, drop one off, take one with me. It's just less stress."* (P3).

4.2.5.3.2 Bus Routes

Some participants experienced difficulties with the set courses and schedules of public buses. Participants reported that it was particularly challenging when they had to take multiple buses to get to a destination and risk missing the transfer time. One participant who had to take two buses, totaling over an hour one way of travel found it aggravating: *It'd be frustrating and irritating, especially with a baby.* (P1) [cross coded with outcome: effect of exertion: mental].

4.2.5.3.3 Funding

When financial aid became available during the COVID-19 pandemic to charge zero fare for the public bus, participants stated that it alleviated financial burdens. One participant was able to direct the savings to purchase other items: *"Definitely it affected me somehow because that money I used to pay for the bus I would have used it for something else and then also to buy something for my baby or for me."* (P6) [cross coded with tools and technology: public bus].

Though the bus was free, one participant felt that there was a decline in the quality of service: *"Because they run free now, they don't exactly run on schedule. You're just supposed to be grateful for what you get because it's free."* (P2) [cross coded with tools and technology: public bus].

4.2.5.3.4 Mask Mandates

When face coverings were no longer required to wear, one participant expressed their concerns about contracting airborne diseases: "*Then, there's just the fact that you don't have to wear masks and things like that anymore, so I'm more susceptible to any sicknesses that that driver may or may not have—or may have."* (P2) [cross coded with person: biomedical characteristics; person: experience of pregnancy; outcomes: assumed risk: exposure to infectious diseases].

4.2.5.3.5 Medicaid Transportation

The policies surrounding transportation provided by Medicaid often hindered transportation access for participants. One participant felt that the advance noticed needed for booking transportation was a barrier: *"I feel it's a long process 'cause sometimes you have to book the appointment two days before and sometimes maybe you don't find that time and stuff like that."* (P15) [cross coded with tool and technology: non-emergency medical transportation]. Another participant experienced long wait times to be picked up from appointments because the transportation service was not required to wait: *"I have to wait three hours in order for them to come back to take me home even though the appointment was only set for 30 minutes."* (P2).

4.2.5.3.6 Running Late to Clinical Appointments

Participants reported that the type of transportation they used affected the ability to be on time to health care appointments. Whether they could be seen by a health care professional depended on how late they were to an appointment. Participants experienced that if they were less than 15 minutes late, then they could still be seen: *"If it's an acceptable period of time, like maybe 5 to 10 minutes, he [the doctor] waits, but if it's past that I have to reschedule for another day."* (P8). One participant who relied on Medicaid transportation was late to appointments multiple times and was at risk on not being able to be seen by their preferred provider: *"I just stopped usin' it [Medicaid transportation] once I was at risk of losin' my OB because of constant missed appointments due to them being unreliable"* (P2) [cross coded with tools and technology: non-emergency medical transportation].

4.2.5.3.7 WIC Benefits

The participants who received benefits from the WIC program felt that it was easier to receive their benefits when they did not have to go in-person to a WIC clinic. As this was a policy change due to the COVID-19 pandemic, one participant thought it would be burdensome to have to access transportation if the policy reverted back to in-person requirements: *"I feel I wouldn't like that policy because I know you have to bring both children in. I don't know. I don't see that as beneficial...I just see that as unnecessary."* (P3).

4.2.5.3.8 Work Leave

Of the participants who worked, most had to take a half day to a full day off of work to attend clinical appointments. Participants noted that amount of time needed away from work was determined in part by their transportation mode. The participants who were able to take off from employment, especially paid time off, conveyed that it was easier to attend clinical appointments. For the participants who did not have paid time off of work, they experienced challenges with attending clinical appointments. For one participant, their work policy did not allow them to miss a certain amount of days. This participant described how this policy was frustrating, especially because they needed a full day off of work to attend clinical appointments: *"[The policy is] really frustrating, and I feel like I don't have the time that I need*

to have for myself or the kid. I may not be able to keep on asking for time off, so I need the job, so you just kind of let it go. It feel bad, definitely." (P8) [cross coded with outcomes: missed and delayed medical care]. Another participant had to cancel an appointment because of their workload: *"...the time I had a lot of work, and I couldn't manage to meet my doctor, so we had to reschedule the time"* (P5). [cross coded with outcomes: missed and delayed medical care].

4.2.5.4 Scheduling

When participants were late to or missed an appointment due to delays in accessing transportation, they experienced difficulties with health system operations and logistics in trying to access health care in timely manner. Some participants reported having to wait additional time to see a health care professional on the same day. For others that were too late to their appointment to be seen in the same day, they mentioned having to wait days and sometimes even weeks to reschedule their appointment: *"Well, usually a few weeks after an appointment [to reschedule]. Say I reschedule, and it's usually—I can reschedule to a few weeks after, or if it's urgent, maybe the next week. It's never really an immediate time..."* (P3) [cross coded with outcomes: missed and delayed medical care].

4.2.6 Physical Environment

External conditions, both built and naturally occurring, affected participants' ability to access transportation to maternal health services.

4.2.6.1 Built Environment

Participants reported that the availability and condition of bus stop shelters, bus stops, parking, and pedestrian infrastructure in addition to the location of clinical and social services, stores, and recreational places affected transportation access.

4.2.6.1.1 Bus Stop Shelters

Structures available at bus stops helped to protect participants from adverse weather conditions as well as provided a place to sit down if a bench was available. A participant found that shelters were beneficial in hot weather: *"...when I have the shelter—sometimes, when I miss my bus, I can usually wait there for quite some time. It's not that hectic. When I go to the*

bus stop without shelter, sometimes the weather is too hot, and it becomes uncomfortable." (P14) [cross coded physical environment: weather; outcomes: effects of exertion: physical]. Though shelters were available at some bus stops, participants reported that the conditions were not always favorable. One participant described how the condition affected their ability to use the shelter: *"Somebody shot up the seats and stuff. Blew little holes in the seats and all that extra stuff...It really ain't no seat no more because everything got shot up, the glass and everything."* (P1).

4.2.6.1.2 Location of Bus Stops

Participants typically were located within a 10-minute walk from their homes to places to catch the bus. However, the distance to a bus stop near where they were going varied. Some participants chose to access services with bus stops placed specifically at those locations. However, for one participant, their doctor's office was located a 45-minute walk from a bus stop: *"There was a point I went to visit my doctor and check in on the app. It was like half an hour to reach the bus stop—not half an hour, I think it was 45 minutes for me to reach the bus stop..."* (P5) [cross coded with physical environment: built environment: location of clinical and social services]. All participants walked to bus stops, which had varying effects for participants at different time points throughout the maternal care continuum. Having to walk to a bus stop carrying a child was burdensome for one participant: *"Because I have to walk to the bus stop, wait with my child. He's so heavy."* (P10) [cross coded with person: experience of pregnancy; outcomes: effect of exertion: physical].

4.2.6.1.3 Location of Clinical and Social Services

The placement of organizations that provide health related services influenced where participants sought care and the modes of transportation available to them. Participants who were in 5-10 minutes walking distance of clinical services felt that the exercise helped them during their pregnancy: *"I think I was used to it because most of the time I could just be walking, yeah, so it wasn't that hard for me. I didn't feel any stress about it because I think it boosted my energy, not just staying in the house or just lying around...At least walking, I felt like it helped me."* (P16). One participant chose to seek clinical care 20 minutes away by car because of the

quality of care they received: *"[I prefer travelling farther]...'cause their facilities are nice and accommodating."* (P13). Another participant could not access their preferred care provider by bus: "*The bus doesn't go to my doctor's office. It's out in [city] pretty far out, and the buses don't go that way"* (P2) [cross coded with organizational environment: policy: bus routes]. Some participants were able to access services through telehealth. One participant felt that this alleviated financial burdens: *"It was so helpful [telehealth] 'cause the gas I would have used to drive to get to the one-on-one, it saved me a lot"* (P5) [cross code with person: socioeconomic factors; tools and technology: internet]. For another participant, being able to access mental health services on the phone eliminated stressful driving situations: *" [the mental health service is] maybe a 10-minutes drive, it's kinda hectic sometimes. I just feel like it's taking too long, where it's much too long."* (P18).

4.2.6.1.4 Location of Recreational Places

Three participants mentioned recreational places as locations that promoted their health during and after their pregnancies. One participant described the mental health effects of engaging with art: *"Going to the [art museum], it's actually, boosts my energy and how I look at things. It tends to help me look at things in a more positive way because when I get there, I see the fine arts in the museum. It, actually, gives me the positive side of life. Yeah, let me say, in a way, it affects my life and my mental health positively because when I get there, I usually just feel at peace and comfortable, happy and joy."* (P9). Another participant was able to take the bus to a recreation center to engage in social activities: *"I could get to see other—you get to see different people. It's so fun... This is where people are doing baby showers, they visit, their kids are playing."* (P17).

4.2.6.1.5 Location of Stores

A majority of participants lived within walking distance of at least a store that carried basic food items. One participant described the items they were able to buy with the Supplemental Nutrition Assistance Program (SNAP) at a dollar store: *"There's a Dollar General literally right down the hill. Yeah. Use the little food stamp card, get food like yogurt...cereal for the baby and stuff. Get me some chips, somethin' to drinks for the house, some milk for the*

house...Walk back home." (P1) [cross coded with outcomes: ability to access necessary items: food availability]. However, the same participant found that they had to travel further to larger stores to find items that were approved to buy with WIC benefits: *"I'll go to Walmart or Food Lion for that [to redeem WIC benefits]."* (P1) Though stores were conveniently in walking distance for some participants, participants reported having to go to the store frequently because they could not carry all of the items they needed at one time or without assistance: *"I barely go and carry the heavy stuff alone. Most of the times when I go alone, I carry light stuff, like let's say groceries that I'm going to use for supper at that time." (P14)* [cross code with tasks: frequency].

4.2.6.1.6 Parking

Participants found it easier to access maternal health services when parking was readily available. One participant found it difficult to find parking near their doctor's office: *"If I could as least as I could, instead of walking across the street, across the—in front of the moving cars, if I didn't have to do all that and was able to get parked in the maternity area parking lot and then just walk right through those doors, but they don't have that at that particular OB/GYN office."* (P3) [cross code with physical environment: built environment: location of clinical and social services; outcomes: assumed risk: exposure to hazardous road conditions]. Another participant liked to go to the river to relax, but often couldn't find parking: *"I love to be able to just going in, hanging out there [the river]. There are some days I couldn't just go 'cause the overcrowding at times and the lack of parking. Those were the things that I felt bad not being able to access them, but it is recreational stuff." (P18)* [cross code with physical environment: built environment: location of recreational places]. Limited parking availability during certain hours at their doctor's office caused one participant to use a rideshare service: *"It depends on the times, the time when I had the appointment, many a times in the morning, somehow it's difficult to get a place to park, and late in the evening, it's difficult to get a place to park your vehicle. When I had appointments, maybe during the evening hours or early morning hours, I would choose to just use an Uber rather than maybe my personal vehicle because parking would*

be a problem...I know how stressful it can be finding a place to park your vehicle." (P15) [cross code with tools and technology: rideshare services].

4.2.6.1.7 Pedestrian Infrastructure

Participants described feeling safe walking to bus stops and maternal health services when sidewalks were present and in good condition. Though participants mainly expressed that crosswalks also made them feel safe, one participant when they were pregnant felt that they had to cross fast to avoid harm: *"I'm extra careful, just like what I had already said. When you're heavy, you have to be so careful. You have to know that you're safe when you're crossing. You cross carefully, a bit faster."* (P18) [cross coded with person: experience of pregnancy; outcomes: assumed risk: exposure to hazardous road conditions]. In instances where there were not sidewalks, participants expressed concerns about the potential for harm to occur: *"...someone might bump into you. That might cause harm to the baby or to you, you might fall down and cause harm to the baby. It was somehow not secure, somewhat not safe for me."* (P6) [cross coded with outcomes: assumed risk: exposure to hazardous road conditions].

4.2.6.2 Weather

The naturally occurring conditions outside affected whether participants would access maternal health services. When asked how a participant would access maternal health services during adverse weather conditions, they stated: *"I just wouldn't go outside. I'd just reschedule it."* (P1) [cross code with outcomes: missed and delayed medical care]. Another participant avoided going outside during the heat: *"When the weather is too hot, I tend to get some fever. I get fever. I guess it's from the heat."* (P14) [cross coded with outcomes: effect of exertion: physical]. For another participant, waiting outside for the bus on rainy days was not option due to their concerns about their child getting sick: *"I would try and wait until it stops because I can't really get out of the house and go wait for a bus. It doesn't make sense running around with a kid. That will just make things worse if I get sick or baby gets sick."* (P16).

4.2.7 Social Environment

4.2.7.1 Culture

The norms and practices of particular groups of people, particularly experiences discrimination, caused participants to travel further to seek clinical care. Two participants reported experiencing unjust or prejudicial treatment from health care professionals and health systems. After experiencing discrimination at one health system during their first pregnancy, a participant decided to not seek care at the same health system, which is located closest to where they reside: *"[Health system] is closer for me to go to, but with my first child, I had my OB/GYN there. I've noticed that a trend with women of color where, when we go to the doctor and we are expressing there's an issue wrong, we're not really listened to."* (P2) [cross coded with tasks: duration; physical environment: built environment: location of clinical and social services]. Another participant was hesitant to seek care at a new clinical site that opened up closer to where they lived due to the potential for discrimination: *"What I hate with several hospitals is issues to do discrimination that happens. It's better at the hospital that I'm used to, 'cause I used to—this has been my hospital ever since even before the pregnancy. I prefer the one that I'm used to better, the one that I'm used to rather than going to a new one despite the distance..."* (P15) [cross coded with tasks: duration; physical environment: built environment: location of clinical and social services].

4.2.7.2 Personal Network

Participants received assistance from family and friends through childcare, direct transportation access, and indirect transportation access.

4.2.7.2.1 Childcare

As noted in previous themes, participants found it difficult to bring their children with them when accessing maternal health services (see task: difficulty; tools and technology: infant care items; outcomes: effect of exertion). When attending clinical services, a participant's sister was able to come to their house to watch their child: "*I prefer her coming to my house 'cause it's way easier not carrying things around and everything."* (P7). Another participant described

the process of coordinating child care with their partner so they could go grocery shopping: *"I go out every two days, so I have to look for times that my partner is around so that he can stay with the kids. I can't just go, and no one is taking care of the kids. Parenting's about planning, so we just plan everything. You have to know what time he's supposed to be in the house, so that I can do other things."* (P18) [cross coded with task: coordination].

4.2.7.2.2 Direct Transportation Assitance

Participants' personal network members also assisted with transportation access by driving participants to services and by loaning their vehicles to participants. A participant found it easier to get to their clinical appointments when their partner was able to drive them: *"I get to go to my appointment early. I don't have to strain—I wake up early, so I have to do some things—I do things at my own time, at my own pace. Unlike the bus—it stops at every stop to drop people and pick people—we just go direct, straight up to the hospital."* (P14) [cross code with tools and technology: car]. Another participant shared a car with their mother; however, whether they could use the car was dependent on if there was a certain level of gas in it: *"...'cause we share the car with my mom, so at times, she might leave with it and come back, and she doesn't inform me if the gas is gone, so before I have to get out of the house, I have to make sure if the gas is enough for me for where I'm heading to, to when I'll get back."* (P5) [cross code with tools and technology: car].

4.2.7.2.3 Indirect Transportation Assistance

Participants' personal network members also used their personal vehicles to pick up and deliver items to them. For example, when a participant could not find items at the nearest grocery store, they asked their partner to drive to a store where the items were available: *"The things that I don't get there [the grocery store within walking distance], I send my boyfriend to bring them."* (P14) [cross code with physical environment: built environment: location of stores]. Most participants felt that it alleviated stress if personal network members could bring groceries and baby items to them.

4.2.7.3 Strangers in Public Places

Participants mentioned that the presence of unfamiliar people in common areas, like the public bus, made them feel uncomfortable and sometimes unsafe. Most of the time, participants felt uncomfortable when people stared at them on the bus: "*Having a baby in a new mode of transport sometimes it's not comfortable because the baby cries and it draws attention. I felt like a lot of people were looking at me and in a disgusting manner, because it's annoying when you have a child and she's crying and you can't calm her down..*" (P11) [cross code with tools and technology: public bus; outcomes: effect of exertion: mental]. Another participant felt that taking the bus was *"rough [because] "...people be gettin' crazy on the bus, doin' drugs on the bus and all this extra stuff..I think it messes up my mental [health]…*" (P1) [cross coded with outcome: effect of exertion: mental].

4.2.8 Outcomes

Participants reported various impacts of attempting to access and accessing transportation to maternal health services including being able to access necessary items, assuming risks, being stranded, experiencing effects of exertion, making financial tradeoffs, being subject to medical negligence, missing or delaying medical care, and taking time off of work.

4.2.8.1 Ability to Access Necessary Items

4.2.8.1.1 Food Availability

For the most part, participants were able to access a store within walking distance. However, the accessibility and affordability of nutritious foods varied for participants. The lack of availability of WIC approved items at stores frustrated one participant: *"My problem is bread. It doesn't matter. I eat wheat bread, so I get the bargain, the normal store brand the Food Lion or Kroger. I get that brand, but it never covers it. Then I'm havin' a problem finding the cheese that is covered through WIC. It's a lot of trial and error, and that's frustrating because whatever isn't covered, I just have to pay out of pocket for, even though I thought it was covered with WIC."* (P3) [cross coded with organizational environment: operational dysfunction]. Even though another participant received government assistance to purchase food, they still needed

supplemental food items dropped off by a non-profit organization: *"I don't get any emergency food stamps like everybody else is doin'. That [having food dropped off by a non-profit organization] helps me a lot."* (P1) [cross coded with person: socioeconomic factors; organization environment: home and community-based services: non-profit organizations].

4.2.8.1.2 Infant Care Item Availability

Though some participants were able to easily access food items, accessing items specifically for babies was challenging for most participants. One participant was only able to purchase a small amount of the items they needed at the store located near their home: *"...[the closest store] do[esn't] have a lot of baby stuff, but I can get some of them. Not all. Not even close to half. Let's say a quarter of the things that I need, yeah."* (P14). [cross code with physical environment: built environment: location of stores]. To access these items, some participants had support from their personal network: *"Most of the baby products, it's my partner who comes with them. Most of the time, I just buy the food products, things like that."* (P14) [cross code with physical environment: built environment: location of stores; social environment: personal network: indirect transportation access].

4.2.8.2 Assuming Risks

Participants felt that they had to expose themselves to potential danger, including hazardous road conditions, infectious diseases, and other people, to access maternal health services.

4.2.8.2.1 Exposure to Hazardous Road Conditions

Participants described exposing themselves to dangerous traffic environments when walking to and from bus stops as well as directly to maternal health services. One participant felt traumatized by carrying their infant on a road with car traffic: *"I hate car traffic. It gives me a lot of trauma, and my baby wasn't used to that kind of noise, so she just kept on crying, wailing, I don't like it at all."* (P11) [cross coded with outcomes: effect of exertion: mental]. Another participant feared getting hit by a car at night: *"It's risky. As a pregnant woman walking at night..[a car] can just kind of mistakenly hit someone..."* (P12).

4.2.8.2.2 Exposure to Infectious Diseases

When using rideshare services or taking the bus, participants expressed fears that they would contract a communicable disease. Once mask mandates were lifted for rideshare services, a participant felt that they were taking a higher risk of contracting an illness: *"..there's just the fact that you don't have to wear masks...so I'm more susceptible to any sicknesses that that driver may...have...when pregnant—and I'm not the most healthy person when I am pregnant. Usually, there's a risk that I won't make it based off of the conditions that I have..."* (P2) [cross coded with person: biomedical characteristics; organizational environment: policy: mask mandates].

4.2.8.2.3 Threats to Personal Safety

Specifically when taking the bus, a few participants recounted instances where they experienced potentially harmful situations created by others. One participant described their experience: *"People ain't safe on the bus. Especially with pregnant people know...They feel like they could just walk about to you. Oh. Can I rub your belly, or this, that and the third, or force their self in front of you. No, hmm-mm, big no for me."* (P1) [cross coded with tools and technology: public bus; social environment: strangers in public places]. When bringing an infant on a bus, several participants experienced strangers trying to touch their child: *"...people come and trying to touch the baby. Oh, they are giving a good gesture, but people keep touching the baby. It's not safe. You just have to just smile at them, 'cause there's nothing you can do."* (P8) [cross coded with tools and technology: public bus; social environment: strangers in public places; outcomes: effect of exertion: mental].

4.2.8.3 Being Stranded

A participant who used Medicaid-sponsored transportation experienced multiple instances where they were not picked up from medical appointments. One time was particularly dangerous due to the heat: *"We're outside in 90-something-degree weather. The building was locked. All the providers went home, and we didn't even get a opportunity to go to the appointment because we were already late. At that point, once they gave us the three-hour time limit—I tried to wait it out, but my kids started to get visibly red... There's nowhere where*

we were able to get them hydration and things like that. I ended up havin' to walk—well, we ended up having to walk a mile and a half, while I'm high-risk pregnant, currently, in the same situation. I just got to a point where I was throwin' up stomach fluid." (P2) [cross code with tools and technology: non-emergency medical transportation; physical environment: weather; outcomes: effects of exertion: physical].

4.2.8.4 Effects of Exertion

Participants unanimously experienced acute impacts on both mental and physical health when trying to access transportation.

4.2.8.4.1 Mental

Participants described a myriad of feelings when accessing transportation, including anxiety, stress, irritation, frustration, sadness, and depression. These feelings especially arose when participants had to navigate car traffic (see outcomes: assumed risk: exposure to hazardous road conditions) and had to interact with people in public spaces (see social environment: strangers in public places; outcomes: assumed risk: threats to personal safety). One participant felt especially frustrated having to take their infant on a bus: *"Having a kid on the bus that's crying, things like that, you feel frustrated...You get depressed. You're trying to calm the baby down."* (P17) [cross coded with tools and technology: public bus].

4.2.8.4.2 Physical

Participants experienced situations where they had to expend physical energy to access transportation. In an instance where a participant could not use their partner's vehicle, they felt exhausted after having to take the bus: *"It is so exhausting [taking the bus]. Mostly at middle trimester, yeah, when I had some urgent errands to run."* (P10). [cross coded with person: experience of pregnancy; tools and technology: public bus]. Carrying infants, even with transport items like car seats and strollers, made it difficult for participants to access transportation: *"That was a lot on my side because I used a lot of energy carrying that seat from one place to another whenever I'm using the bus. I just have to do it for my baby to be comfortable."* (P11) [tools and technology: infant transport items; tools and technology: public bus].

4.2.8.5 Financial Tradeoff

To pay for transportation, participants often had to weigh decisions on what to spend their limited income on. One participant stated that they decided to pay for a rideshare service to a clinical appointment instead of food and infant care items: *"Sometimes I have to deny myself something or something I had to buy for the baby just to save the money to pay Uber for an appointment to hospital..."* (P15) [cross code with person: socioeconomic status; tools and technology: rideshare service]. Another participant experiencing a similar dilemma chose to use a rideshare service over buying a car seat: *"I, currently, can't get a car seat because of the expenses that come down with Lyft...It's extremely inconvenient to have to get to my doctors' appointments with that ride, but also extremely necessary because it's not safe for me to drive right now."* (P2) [cross code with person: socioeconomic status; tools and technology: rideshare service]. When the bus fare was eliminated due to the COVID-19 pandemic, one participant felt that they did not have to make as many financial tradeoffs: *"Definitely it affected me somehow because that money I used to pay for the bus I...used it for something else and then also to buy something for my baby or for me."* (P6) [cross code with person: socioeconomic status; tools and technology: public bus; organizational environment: policy: funding].

4.2.8.6 Medical Negligence

One participant described an experience where they felt health care professionals failed to perform duties in line with best practice: *"...when I gave birth at [the hospital]...I got cut with the epidural needle three times because of the negligence of the person that was administering epidural. It was just a lot of adversity tryin' to go to the place that was closest to me."* (P2) [cross coded with physical environment: built environment: location of clinical and social services]. Since this participant *"fear[ed] for [their] life [at this hopsital]"* they "*made sure that [they] had gotten a ride while [they were] actively in labor with [their] second child...so that [they] would never have to go through the experience that [they] went with [that specific hospital]."* (P2) [cross coded with physical environment: built environment: location of clinical and social services].

4.2.8.7 Missed and Delayed Medical Care

Participants recounted numerous occurrences where they were either late to health care appointments or had to reschedule or cancel these appointments due to issues with transportation access. Participants were late to appointments because the bus was not on schedule, their car was not working, or scheduled transportation did not pick them up. It most instances participants said that they were still able to be seen by a health professional in that same day. In one case, a participant who had to take two buses to get their health care professional would have to reschedule if the bus connection took too long. This participant described the effects rescheduling had on them: "*I just be moody, frustrated, and irritated because I be wanting to get it out the way instead of rescheduling the appointment and have to go back."* (P1) [cross code with outcomes: effects of exertion: mental]. Participants who were too late to their appointments had to reschedule. Participants experienced several issues with rescheduling, including having to coordinate childcare or transportation and having to request time off of work again.

4.2.8.8 Taking Time Off of Work

For the participants who did not have paid time off of work, they had to reduce hours spent working, which subsequently affected income. One participant described this effect: *"[taking time off of work] affects my income in that, this time that I'm going to the hospital, I could be making money, but now, I'm not making that money because I have to go to the doctor's appointment."* (P14) [cross coded with person: socioeconomic status; outcomes: financial tradeoff]. Another participant had to take a whole day off of work because the location of their health professional's office was far away from their place of employment: *"I usually have to just take the whole day off or only come to work for an hour, two hours, and that's really not worth the drive."* (P3) [cross coded with physical environment: location of clinical and social services].

4.3 Systems Mapping

4.3.1 Overview of Themes

Two deductive themes were used to code interaction types: facilitative and inhibitory. A codebook is available in Appendix C Table C3. The consolidated systems map graphically depicting interactions and workarounds embedded in the enhanced patient work system is available in Appendix C Figure C2.

4.3.2 Interactions

Participants discussed the combined effects of sub-factors as being facilitative and inhibitory in

nature. Facilitative interactions were relationships between and among distinct sub-factors that resulted in improved transportation access as it relates to a distinct outcome. Inhibitory interactions were relationships between and among distinct sub-factors that resulted in disrupted transportation access as it relates to a distinct outcome. As some interactions had a dual nature (i.e. at times acted as facilitative and other times, inhibitory), they are discussed concurrently.

4.3.2.1 Interactions within the Microergonomic Triad

Participants reported varied interactions with the microergonomic triad. One participant described an inhibitory interaction among person: biomedical characteristics, task difficulty, and tools and technology: car since their health condition made it hard for them to drive. This led to the outcome: missed and delayed medical care. The experience of pregnancy made it more challenging for participants to carry infant transport items, creating inhibitory interactions among person: experience of pregnancy, task: difficulty, tools and technology: rideshare services, and tools and technology: public bus, contributing to the outcome: effect of exertion: *"It's tiresome, [laughter] at times so annoying because getting to the bus stop, unfolding the stroller, or trying to have to ask for someone to help you carry the stroller inside, so it's very stressful."* (P9). Participants reported that socioeconomic factors served as an inhibitory interaction between tools and technology: public bus, car, and rideshare services, leading to the outcomes: financial tradeoff and outcomes: missed and delayed medical care: *"Sometimes I*

have to deny myself something or something I had to buy for the baby just to save the money to pay Uber for an appointment to hospital..." (P15).

4.3.2.2 Interactions Between and Among Microergonomic and Macroergonomic Factors

4.3.2.2.1 Organizational Environment

Participants felt that midwifery and non-profit organization services offered in household and community settings served as a facilitative interaction as it eliminated the need to access transportation, and improved access to care and availability of necessary food items: *It [the organization] helps women with lots of stuff. Sometimes they call us and tell us that they have fruits, vegetables, grains. They have milk, so whoever wants or needs can just make a way there, get some. Yeah, sometimes they do counseling..."* (P18).

Participants discussed inhibitory interactions among policy: mask mandates and person: biomedical characteristics, tools and technology: public bus and rideshare services, and experience of pregnancy, as these conditions affected their immune systems, contributing to the outcome assuming risks: exposure to infectious diseases: "*Then, there's just the fact that you don't have to wear masks and things like that anymore, so I'm more susceptible to any sicknesses that that driver may or may not have—or may have."* (P2).

Participants detailed instances of operational dysfunction when the bus and non-emergency medical transportation were running late or did not show up, creating inhibitory interactions among operational dysfunction tools and technology: public bus and non-emergency medical transportation and tasks: duration, effecting outcomes: effects of exertion: mental and physical and missed and delayed medical care: *"...the bus tends to delay. It just delays out of the blue. That wasn't what I was expecting. When the bus tends to delay, I have to delay, also, my appointment, the things that I was going to do. I tend to go late...I don't like delaying things. I feel as I'm going to delay something or I'm going to get late. Sometimes I panic out."* (P14). Further inhibitory interactions were reported with policy: running late to clinical appointments, where participants stated that they have to cancel or reschedule their appointments depending on how late they were: *"If it's an acceptable period of time, like maybe 5 to 10 minutes, he [the doctor] waits, but if it's past that I have to reschedule for another day."* (P8). Having to reschedule then served as an inhibitory interaction with

scheduling as participants reported having to wait weeks for another appointment: *Well, usually a few weeks after an appointment [to reschedule]. Say I reschedule, and it's usually—I can reschedule to a few weeks after, or if it's urgent, maybe the next week. It's never really an immediate time..."* (P3). Participants then detailed another inhibitory interaction between policy: leave and person: socioeconomic factors as they had to take more time off of work to access services, affecting the outcomes: financial tradeoff and taking time off of work: *"[The work leave policy is] really frustrating, and I feel like I don't have the time that I need to have for myself or the kid. I may not be able to keep on asking for time off, so I need the job, so you just kind of let it go. It feel bad, definitely."* (P8). All of these interactions contributed to the outcome: missed and delayed medical care.

4.3.2.2.2 Physical Environment

Participants reported that bus stop shelters served as an inhibitory interaction with weather, tools and technology: public bus, and person: experience of pregnancy, affecting the outcome: effects of exertion: physical: *"...when I have the shelter—sometimes, when I miss my bus, I can usually wait there for quite some time. It's not that hectic. When I go to the bus stop without shelter, sometimes the weather is too hot, and it becomes uncomfortable."* (P14). This interaction was facilitative when bus stop shelters were available. This same dual interaction occurred with the location of bus stops, location of clinical and social services, pedestrian infrastructure, where the distance walked and the conditions of the walk determined the outcome assumed risk: exposure to hazardous road conditions and effects of exertion: mental and physical. Participants discussed an inhibitory interaction among parking, pedestrian infrastructure, location of clinical and social services, and location of recreational places, where the lack of parking close to these locations and safe pedestrian infrastructure influenced the outcomes: assuming risks: exposure to hazardous road conditions; effect of exertion: mental and physical: *"If I could as least as I could, instead of walking across the street, across the—in front of the moving cars, if I didn't have to do all that and was able to get parked in the maternity area parking lot and then just walk right through those doors, but they don't have that at that particular OB/GYN office."* (P3).

4.3.2.2.3 Organizational Environment and Physical Environment

Participants detailed inhibitory interactions between organizational environment: bus routes, physical environment: location of clinical services and location of stores, and tools and technology: public bus, contributing to the outcomes: missed and delayed medical care and availability of necessary items: "*The bus doesn't go to my doctor's office. It's out in [city] pretty far out, and the buses don't go that way"* (P2).

4.3.2.2.4 Social Environment

Participants described strangers in public places as an inhibitory interaction with tools and technology: public bus, affecting the outcomes: assuming risks: threats to personal safety and effects of exertion: mental: *"...people come and trying to touch the baby. Oh, they are giving a good gesture, but people keep touching the baby. It's not safe. You just have to just smile at them, 'cause there's nothing you can do."* (P8).

4.3.2.2.5 Physical Environment and Social Environment

Participants detailed both facilitative and inhibitory interactions among social environment: childcare, tools and technology: public bus, task: coordination, task: difficulty, physical environment: location of stores, and physical environment: location of bus stops. If childcare could be coordinated, participant stated that it was easier to walk to bus stops and use the bus to go to the store. If childcare could not be coordinated, this task became much more difficult, and participants explained that this led to the outcome: ability to access necessary items since they were not able to carry as many items along with their child and outcome: effects of exertion: mental: *"It's so depressing [when childcare can't be coordinated] because I just go and pick a few things and not the things that I want."* (P12). Participants detailed a facilitative interaction among direct and indirect assistance from their personal network members, tools and technology: car, and task: coordination, further interacting with physical environment: location of stores and location of clinical and social services this helped participants to receive maternal health services and improved the ability to access necessary items: *"The things that I don't get there [the grocery store within walking distance], I send my boyfriend to bring them."* (P14).

4.3.2.2.6 Organizational Environment, Physical Environment, and Social Environment

Participants reported that culture served as an inhibitory interaction with physical environment: location of clinical and social services as discrimination caused participants to seek care at places farther away from where they live, increasing tasks: duration, influencing outcomes: medical negligence and effect of exertion: *"...when I gave birth at [the hospital]...I got cut with the epidural needle three times because of the negligence of the person that was administering epidural. It was just a lot of adversity tryin' to go to the place that was closest to me."* (P2). Since they had to travel further away, one participant then became reliant on tools and technology: non-emergency medical transportation and through operational dysfunction experienced the outcome: being stranded in adverse weather conditions, further effecting outcome: effects of exertion: *"We're outside in 90-something-degree weather. The building was locked. All the providers went home, and we didn't even get a opportunity to go to the appointment because we were already late. At that point, once they gave us the three-hour time limit—I tried to wait it out, but my kids started to get visibly red... There's nowhere where we were able to get them hydration and things like that. I ended up havin' to walk—well, we ended up having to walk a mile and a half, while I'm high-risk pregnant, currently, in the same situation. I just got to a point where I was throwin' up stomach fluid."* (P2).

Chapter 5 Discussion

5.1 Summary of Findings

This research sought to extend sub-factors of the patient work system to encompass SDOH. Through a case study focused on transportation access to maternal health services, interviews were conducted with 20 health care and human services professionals and 18 birthing persons of color with low-income to elucidate sub-factors within the patient work system. From these interviews, systems maps were created and reviewed by participants to capture interactive relationships between and among sub-factors and outcomes.

Twenty-seven secondary themes and 15 tertiary themes were derived inductively under the seven deductive themes of the patient work system framework from the interviews with health care and human services professionals. From the interviews with birthing persons, 33 secondary themes and 28 tertiary themes were derived inductively under the deductive framework.

From the systems mapping with the interview data from health care and human services professionals, one inductive theme emerged in addition to the two deductive themes. Interactions were found between and among the sub-factors in the microergonomic triad and in the microergonomic triad and all of the macroergonomic domains. Interactions were also found across the microergonomic triad, physical environment, and the organizational environment. With regard to systems mapping with the interview data from birthing persons, two deductive themes were used to categorize the data. Interactions were present between and among the sub-factors in the microergonomic triad and in the microergonomic triad and all of the macroergonomic domains. Interactions were also found across the microergonomic triad, physical environment, and the organizational environment; the microergonomic triad, physical environment, and the social environment; and the microergonomic triad, organizational environment, physical environment, and social environment.

5.2 Comparison to Previous Literature

From the interviews with both study groups, some secondary and tertiary themes were reflective of sub-factors identified in previous literature (Holden et al., 2015a, 2017a; Werner et

al., 2021) and others were uniquely identified by this research. Unique sub-factors are noted in the respective codebooks in Appendix B Table B2 and Appendix C Table C2. Among the unique factors identified, the most salient exist in the domains of the social, organizational, and physical environments. Within the social environment, some birthing persons reported experiencing discrimination when seeking clinical care. Consequently, they traveled to other health care professionals that were farther away from their residence, adding time and costs to accessing transportation. Patient work system models have yet to incorporate elements of discrimination and to consider how forms of oppression, including but not limited to racism, ableism, genderism, sexism, and classism, shape patient work. In the organizational environment, participants in both study groups reported operational dysfunction namely in transportation services provided by Medicaid and within the public transit system. Though previous literature has explored the effects of policy factors on patient work, there has been no recognition of breakdowns in policy, which this research has shown to have a negative effect on outcomes. Moreover, this research expands the types of policy identified in previous research, going beyond health system and insurance company policies, to include policies of public assistance programs, like Medicaid and WIC, and how these policies are implemented at federal, state, and local levels. Participants from both study groups described several factors in the built environment related to transportation access. Though the built environment has been incorporated as a sub-factor in the patient work system, this research elucidated additional specific facets of the built environment. Previous research has noted the importance of the location of grocery stores (Holden et al., 2015b, 2017a). This study expanded this by examining food access more specifically in terms of locations that accept government benefits such as SNAP and WIC, highlighting the interplay between the built environment and policy. Additionally, previous literature has noted factors like surface and layout in households and places of business (Holden et al., 2017b). Participants in this study described broader infrastructure such as shelters as bus stops, sidewalk conditions, and the presence of crosswalks as affecting access to maternal health services. Through studying the patient work system through the lens of SDOH, distinct sub-factors as well as contextual nuances to known sub-factors in the patient work system have been elucidated.

A major contribution of this research is the categorization of interactions within the patient work system. To our knowledge, no other studies have graphically mapped the interactions between and among sub-factors and connected them with outcomes and also found interactions across all microergonomic and macroergonomic domains (Werner et al., 2021). Previous work has elucidated interactions between the macroergonomic domains and household and community level factors (Holden et al., 2017a), the microergonomic triad and organizational and physical environments (Werner et al., 2017), person level factors and the macroergonomic domains (Werner et al., 2018), and the sub-factors within physical environment of a home (Doutcheva et al., 2019). This study found interactions between and among the sub-factors in the microergonomic triad and in the microergonomic triad and all of the macroergonomic domains. In other words, this research identified third order and fourth order interactions encompassing microergonomic and macroergonomic domains while previous work has elucidated first order and second order interactions between microergonomic factors and macroergonomic domains and within macroergonomic domains. Examples of novel interaction types can be found in Figure B3 and Figure C3. By examining all work system components and their interactions, a more holistic model of the patient work system can be used to understand complexities within contextual realities, allowing for the better alignment of interventions.

5.3 Design and Intervention Guidance

The words “design” from an engineering context and “intervention” from a public health context are used interchangeably in this section. There are multiple domains in which interventions can be developed to improve transportation access to maternal health services. Though, it should be noted that these recommendations should be approved by and co-developed with the communities in which they are implemented in. Moreover, implementation should be studied to ensure ongoing fit with dynamic work system factors.

5.3.1 Organizational Environment

Within the organizational environment, interventions can be developed at multiple levels. From a federal and state policy perspective, Medicaid transportation policies should be

reformed so that birthing persons can schedule transportation on the day of their appointments. Operationally, the implementation of Medicaid transportation should be strictly monitored and evaluated. This service should be held accountable to standards for timeliness and professionalism. Moreover, birthing persons, while pregnant and in the post-partum period, should receive paid time off and coverage for childcare to attend medical appointments. Transportation should also be covered to attend non-medical services that promote maternal health. Being able to use Medicaid transportation to go to WIC clinics should be reinstated. This transportation should also be able to be used to go to stores to redeem WIC benefits. WIC vendor requirements should also be evaluated as the strictness of these requirements make it harder for smaller stores, which may be more accessible by walking or by bus, to become certified vendors (Held, 2022). In the same vein of improving WIC item accessibility, there should be changes in policy so that individuals can order items online for delivery, eliminating the need for transportation access. Lastly, policies implemented during the pandemic that allowed individuals to attend WIC appointments remotely should continue.

As private rideshare companies are donating rides to attend maternal health appointments (Shtull-Leber, 2022), they should note that some birthing persons are uncomfortable getting into a car with a stranger. They should continue to integrate features into their technologies that promote safety and investigate other ways to build trust between riders and drivers. These companies should also consider providing rides to non-medical services that promote maternal health as well.

On the local level, public transit companies should continue to offer zero fare, especially for birthing individuals. They should also re-evaluate policies that do not allow for some infant transport items on the bus and/or re-design buses to better accommodate for these items. Bus routes and schedules should also be re-evaluated with riders to better serve their needs. Lastly, the way bus route information and schedules are presented should be examined for adherence to universal design principles. Translation of any written text should also be made available.

For organizations offering direct maternal health services, they should consider offering services outside of normal working hours so their clients do not have to take time off from work or forgo services because they cannot afford to take off of work. Telehealth visits should

continue to be an option for clients in cases where in-person visits are not medically necessary. They can also consider offering home and community-based services in which their clients reside.

5.3.2 Physical Environment

Changes can be made on the local level within the built environment to promote safe transportation. Areas in need of bus shelters and pedestrian infrastructure should be assessed. The quality of current bus shelters and pedestrian infrastructure should also be evaluated.

5.3.3 Alignment Between Health Care and Human Services

The participants in this study who were health care and human services professionals spoke about performing care coordination activities. For some organizations in the region, formal care coordination programs are starting to be developed. Development of these programs should be informed by lessons learned from care coordination programs related to other conditions (e.g. cancer care). Elements of collaborative work across professionals and between professionals and clients should be scientifically assessed (Holden et al., 2013). Forms of collaborative work can be supported by the development of collaborative health IT (Zachary et al., 2021). By understanding collaboration across entities, programs and digital health interventions can be designed to align across work systems with the goal of improving health outcomes.

As an example of what an intervention could look like, technology could be designed to capture the nature of the services available in the community, providing comprehensive information about the resources available, including transportation, for birthing persons across the region. This platform could also serve as a way for members to report barriers they or their clients are experiencing, serving as a catalyst to promote change. This data could be shared with local policymakers and decision makers. For example, recently the local transit company in Richmond voted on whether to continue to charge zero fare for the bus system. A collaborative technology could have served as a platform to share data about why zero fare is important for

birthing persons, providing a way to support collective advocacy. The same could be done for changing elements in the built environment, such as building and improving bus stop shelters. Collecting data across organizations could help to support grant applications or governmental budget allocations. For example, applying for funding to cover transportation costs for birthing person. A collective model like this could provide a stronger case for sustained funding, as participants in this study mentioned that funding for transportation has ebbed and flowed over time. This could also have a consumer facing component for birthing persons to support patient work and eliminate the need for some types of patient work. This technology could connect birthing persons and health care and human services professionals to support navigation and care coordination, including transportation access. It could consolidate information across systems to reduce the complexity of patient work by listing health care professionals (including information about those that provide telehealth services, eliminating the need for transportation), scanning the availability of WIC approved items in an area, overlaying bus routes, and offering information about places that promote wellbeing, like art museums. These are just a few examples and it should be noted that they present their own layers of complexity for design and implementation.

5.4 Implications for HF/E Research and Practice

This research corroborated existing sub-factors and identified unique sub-factors of the patient work system, expanding our current understanding of the dimensionalities of the patient work system. Models of patient work should be expanded to purposefully incorporate a range of work system factors that stem from SDOH. Methods to expand these models should align with recent conversations about applying HF/E to societal issues (C. Rogers et al., 2020; C. C. Rogers & Valdez, 2021; A. Wooldridge, 2021; A. R. Wooldridge et al., 2018, 2021). Namely, interdisciplinary training and partnerships are needed to elucidate the broader social factors that influence patient work. For example, this research was informed by numerous partners with domain expertise in fields such as urban planning, maternal and child health, community health, policy, and social justice. HF/E researchers and practitioners can contribute to our knowledge of systems modeling in concerted efforts with other disciplines as well as use

participatory approaches to produce holistic understandings of systems and generate interventions that seek to eliminate the health inequities produced by these systems.

5.5 Limitations

Though this study provided key insights into expanding the patient work system to encompass SDOH, limitations should be noted. The topic and sample were limited in scope as this study focused on a single determinant in the context of maternal health among low-income individuals of color living in a specific region. Starting with a narrow scope, however, provided a bounded system in which to contribute to our emerging understanding of how to expand the patient work system. The data collection process was subject to recall bias and social desirability bias. Some interviews were retrospective in nature as the eligibility criteria extended to five years after giving birth, potentially introducing recall bias (Patton, 2014). Though by having a longer temporal horizon, perspectives from before, during, and after the COVID-19 pandemic, which had a significant impact on transportation access, were able to be represented. Additionally, experiences across the maternal care continuum were garnered. As the data were self-reported and asked about a sensitive topic, participants may have consciously or unconsciously responded in ways that were socially desirable (Grimm, 2010). To minimize this bias, participants were reassured that there were no correct or incorrect answers to questions and that it was helpful to have their unique perspectives. With regards to data analysis, creating the systems maps during the interviews with birthing persons may have introduced bias by using the enhanced work system produced from Phase One. However, due to the high likelihood of loss to follow-up in this population, it was determined that having the maps reviewed by the participant was a better method to confirm interpretations of the data as opposed to not having the interpretations confirmed at all. Participants did have the opportunity to change or add any additional sub-factors, outcomes, and interactions.

5.6 Directions for Future Research

Since the time of data collection, there have been changes in the built environment (e.g. increased installation of bus stop shelters) and policy (e.g. Medicaid expansion coverage for doula care) that may be improving transportation access to maternal health services. Additional

qualitative interviews should be conducted to confirm and update the sub-factors and interactions presented in this research. Future research directions fall into four categories: (1) secondary analysis of the data set, (2) qualitative work, (3) quantitative work, and (4) intervention co-design and implementation.

A secondary analysis of the data should be performed to capture elements of the invisible work system. By rendering elements of the invisible work system, visible, interventions can be better aligned across health care and human services. This analysis can be done by conducting an in-depth comparative analysis of the health care and human services professional interviews with the birthing person interviews. Such a study will require significant time and resources to conduct this level analysis needed to determine invisible work elements.

As this research centered around a strictly defined case study, future qualitative research should explore transportation access to other types of services among diverse populations in different locations as well as investigate other SDOH to produce a holistic understanding of dynamic systems. Additional qualitative methods could be used to expand our understanding of the experience accessing transportation. Journaling can be used to gain insights and capture variability over time and also reduces recall bias (Ozkaynak, Valdez, et al., 2021). Photo elicitation transect walks could be conducted to gain a first-hand experience of the process of accessing transportation and to document elements within the environment through another medium (C. C. Rogers et al., 2021). Qualitative research should also extend to family members and friends to capture their experience assisting with transportation access to maternal health services.

Quantitative studies can leverage the qualitative findings from this study to determine areas for further inquiry. A survey instrument could be developed to examine the amount of people who experience specific barriers to transportation with questions based on the inhibitory interactions identified throughout this study. Questions could also be asked regarding the design recommendations proposed above. Additional geospatial analyses could also be conducted, looking at factors like pedestrian infrastructure, road traffic accidents, and bus stop shelter availability both in low-income census tracts and surrounding clinical and social services

and stores. This data could provide further evidence for areas that need improvements to promote safety. All of the data produced through this dissertation will be shared with community partners and community members to co-design interventions to better design transportation systems to align with the contextual realities of those accessing maternal health services. To measure factors such as distance, time, and exertion when accessing maternal health services, studies that use wearables for remote health monitoring could conducted.

To develop and implement the design guidance recommended, the findings of this research will be shared with community partners and community members through methods such as presentations at local meetings, distribution of flyers in community spaces, and posts on social media. Future research should focus on co-identifying and prioritizing areas for intervention. To elucidate this information, participatory design workshops can be conducted (Benda et al., 2020). Methods such as affinity diagramming and dot voting can be used to thematically categorize and prioritize, respectively, intervention areas (Ozkaynak, Sircar, et al., 2021). All design efforts should be conducted in partnership with the community and follow best practices and lessons learned from similar community-based efforts (Richmond Food Justice Alliance & Richmond City Health District, 2020).

5.7 Summary and Conclusions

This dissertation sought to extend the patient work system model to encompass the social determinants of health using a case study of transportation access to maternal health services. This purpose was accomplished through a qualitative interpretive study that engaged 20 health care and human services professionals and 18 birthing persons of color with low-income. Methodologies and methods drawn from public health and human factors engineering shaped the topic of research and data collection, analysis, and interpretation. The results from this study show that there are additional sub-factors that need to be added to the patient work system to encompass the social determinants of health and that there are complex interactions between and among sub-factors that produce both positive and negative health outcomes. The findings from this dissertation are not exhaustive, rather they establish a starting point for

future inquiry. There is a need to continue interdisciplinary research in partnership with community members to further the development of a patient work system model that full encompasses the social determinants of health.

Appendix A

Exhibit A1. Health Care and Human Services Professionals Recruitment Survey

Researchers from the University of Virginia are looking for providers of maternal health services to complete an interview. The purpose of this interview is to understand the services your organization offers and any barriers to providing and/or accessing these services. For those that participate, this study will involve an interview via phone or on Zoom that will take up to one hour. You will receive a $25 gift card for participating in this study. Please continue with this survey if you are interested in participating.
This study has been approved by the Institutional Review Board for Social and Behavioral Sciences Research at the University of Virginia (Protocol #4494). If you have any questions about the study, please contact the study coordinator:

Courtney Rogers, MPH
ccr9sc@virginia.edu
University of Virginia

1. What is your first name?
2. What is your email address?
3. What is your phone number?
4. What is your preferred contact method?
    a. Email
    b. Phone
5. Do you prefer to be contacted via text message or phone call?
    a. Text Message
    b. Phone Call
6. What is the best time to contact you during the week?
    a. Morning
    b. Afternoon
    c. Evening
    d. Anytime
7. What is the best time to contact you on the weekend?
    a. Morning
    b. Afternoon
    c. Evening
    d. Anytime
8. This study has multiple phases. Would you want to be contacted to participate later phases of the study?
    a. Yes
    b. No

Exhibit A2. Health Care and Human Services Professionals Interview Guide

I want to start by hearing more about the services your organization provides and your role.

1. Could you tell me about the organization you work for?
2. What services does your organization provide?
3. What do you do specifically in your role at the organization you work for?

Next, I would like to talk about how your clients access your services.

4. How are your services offered (probe on in person, mail, virtual synchronous, virtual asynchronous, home visits)?
5. How do your clients access your services (probe on public transit, ride services, personal transportation, walking)?
    a. How does this change throughout the maternal care continuum?
    b. How do you think the mode of transportation affects the health and wellbeing of your clients (probe on missed appointments, physical strain, cognitive effort)?
    c. [If they provide home services], what mode of transportation do you use? What transportation barriers, if any, do you experience?
6. What barriers to transportation do your clients experience?
    a. What, if anything, does your organization do to address these barriers?
    b. How do you think these barriers affect accessing other services related to maternal and child health (e.g. access to healthy foods, childcare, behavioral health services)?

I would like to know more about who else is involved in helping your clients access your services, if anyone.

7. Who from a client's network is usually involved in helping them access your services?
8. How do they assist in helping your client access your services?

Now I would like to discuss the broader context, like the environment and policy, that may be affecting your clients' access to your services.

9. How does the weather/season affect access to your services?
10. How do your clients, if at all, adapt their transportation method in unfavorable weather conditions?
11. What is the environment like around the site of your organization (probe on proximity to nearest bus stop, sidewalk quality, parking)?
12. How does the broader policy environment affect transportation access to your services (probe on insurance coverage/reimbursement for transportation to medical appointments, work leave policies)?
13. How do you think these policies affect the health and wellbeing of your clients?

Thinking back to the beginning of the COVID-19 pandemic until now:

14. How has the pandemic affected the way you provide services?
15. Could you tell me about how you have had to adapt your services and the challenges you encountered?

16. What changes did your clients have to make in the way they accessed your services?
    a. How do you think changes in transportation affected the health and wellbeing of your clients?

Lastly, I would like to know about any other factors that affect clients being able to access your services.

17. What other barriers do your clients face in accessing your services?
18. What else helps your clients access your services?
19. Is there anything else we haven't covered but you would like to share with me?

Exhibit A3. Health Care and Human Services Professionals Demographic and Organization Information Survey

Demographic Questions

1. What is your participant number? [free response]
2. What is your age?
    a. 18-24
    b. 25-34
    c. 35-44
    d. 45-54
    e. 55-64
    f. 65+
3. Which of the following describes your race? (Select all that apply)
    a. White
    b. Black or African American
    c. Asian or Asian-American
    d. Native American/Alaska Native
    e. Pacific Islander/Native Hawaiian
    f. Don't know
    g. Some other race [free response]
    h. Choose not to disclose
4. Do you consider yourself Hispanic or Latino?
    a. Hispanic or Latino
    b. Not Hispanic or Latino
    c. Choose not to disclose
5. What is your gender identity?
    a. Female
    b. Male
    c. Transgender female
    d. Transgender male
    e. Other
    f. Choose not to disclose
6. What is your sexual orientation?
    a. Straight
    b. Bisexual
    c. Gay
    d. Lesbian
    e. Pansexual

f. Asexual
g. Queer
h. Something else
i. Don't know
j. Choose not to disclose

Questions about your organization

7. Where is your organization located?
    a. Northside Richmond
    b. Southside Richmond
    c. East End Richmond
    d. West End Richmond
    e. East Henrico County
    f. West Henrico County
    g. Chesterfield
    h. Other [free response]
8. How long has your organization been operating for?
    a. 0-2 years
    b. 3-5 years
    c. 5-10 years
    d. 10+ years
9. What services does your organization offer? (select all that apply)
    a. Doula services
    b. Financial support
    c. Food access
    d. Lactation support
    e. Midwife services
    f. Transportation to medical appointments
    g. Other [free response]
10. At what time points does your organization offer services for? (select all that apply)
    a. Preconception/interconception
    b. Prenatal
    c. Intrapartum/birth
    d. Postpartum
    e. Other [free response]
11. What population(s) do you serve? (select all that apply)
    a. Low-income
    b. Non-English speaking

    c. Black or African American
    d. Hispanic
    e. Other [free response]
12. How are your services financially supported? (select all that apply)
    a. Individual donors
    b. Private organizations/foundations
    c. Public grants
    d. Government-supported health insurance
    e. Private health insurance
    f. Clients pay out of pocket for services
13. If there are any other providers you think would be interested in participating in this study, please list their name and contact information below. (free response)

Exhibit A4. Birthing Individuals Recruitment Flyer

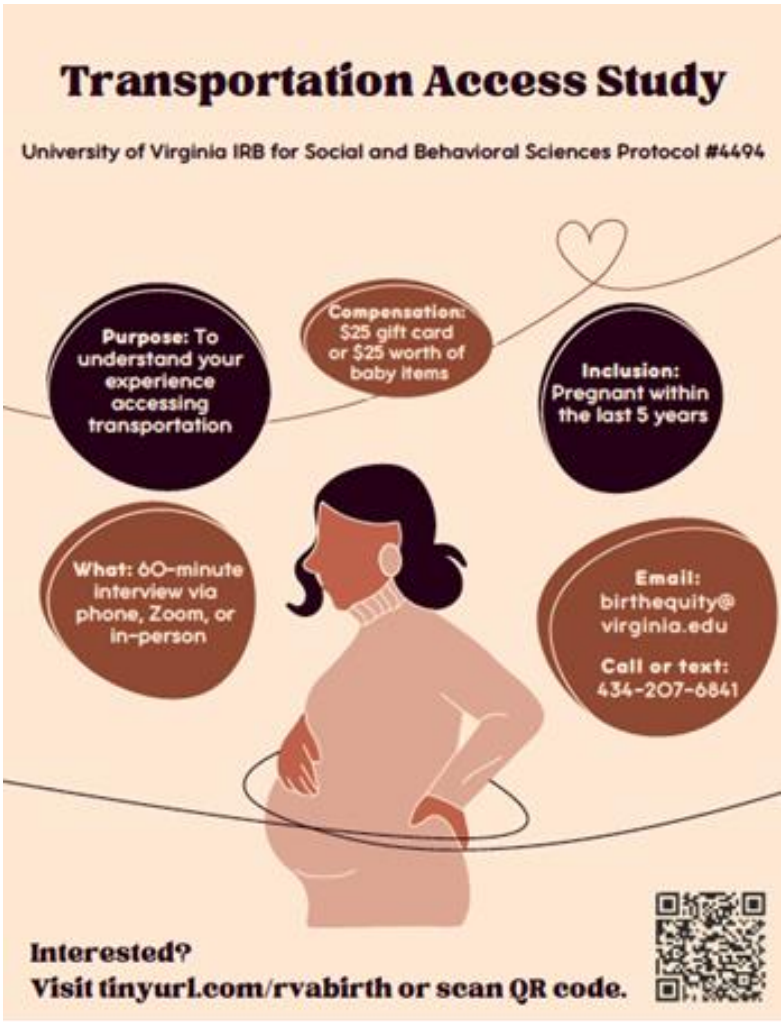


Exhibit A5. Birthing Individuals Eligibility Survey

Study Intro

Researchers from the University of Virginia are looking for individuals who are pregnant or who have been pregnant in the last 5 years. The purpose of this interview is to understand barriers to accessing services related to maternal health. For those that participate, this study will involve an interview in-person, via phone, or on Zoom that will take up to one hour. You will receive a $25 gift card or $25 worth of baby items for participating in this study. Please continue with this survey if you are interested in participating.

This study has been approved by the Institutional Review Board for Social and Behavioral Sciences Research at the University of Virginia (Protocol #4494). If you have any questions about the study, please contact the study coordinator:

Courtney Rogers, MPH
ccr9sc@virginia.edu
Graduate Research Assistant
University of Virginia

Eligibility

1. When was your last pregnancy?
    a. I am currently pregnant
    b. Within the last year
    c. Within the last 2 years
    d. Within the last 3 years
    e. Within the last 4 years
    f. Within the last 5 years
    g. More than 5 years ago [if option is selected, end survey]
2. How many children do you have?
    a. None
    b. I am currently pregnant with my first child
    c. 1
    d. 2
    e. 3
    f. 4
    g. 5
    h. More than 5
3. Is your income level less than or equal to 185% of the Federal Poverty Level (see table below for reference)?
    a. Yes, my income is less than or equal to the amount listed in the table.

b. No, my income is greater than the amount listed in the table. [if option is selected, end survey]

Family/Household Size	Annual Income	Monthly Income
1	$25,142	$2,095
2	$33,874	$2,823
3	$42,606	$3,550
4	$51,338	$4,278
5	$60,070	$5,006
6	$68,802	$5,733
7	$77,534	$6,461
8	$86,266	$7,189

4. What is your age?
    a. 18-24
    b. 25-34
    c. 35-44
    d. 45-54

[If ineligible] Thank you for taking the time to complete this survey! Unfortunately, you are not eligible to participate in this study. If you have any questions, please contact us at birthequity@virginia.edu. Your individual response will be deleted, but we will keep an anonymous summary of the information you submitted.

[If eligible, the survey continued]

Contact Information

5. What is your first name? [free response]
6. What is your email address? [free response]
7. What is your phone number? [free response]
8. What is your preferred method of contact?
    a. Phone
    b. Email
9. Do you prefer to be contacted via text message or phone call?
    a. Text Message
    b. Phone Call
10. Would you like to complete an interview over phone, Zoom, or in-person?
    a. Phone
    b. Zoom
    c. In-person
    d. No preference

Demographic Information

11. Which of the following best describes your race? (Select all that apply)
    a. White
    b. Black or African American
    c. Asian or Asian-American
    d. Native American/Alaska Native
    e. Pacific Islander/Native Hawaiian
    f. Don't know
    g. Some other race [free response]
    h. Choose not to disclose
12. Do you consider yourself Hispanic or Latino?
    a. Hispanic or Latino
    b. Not Hispanic or Latino
    c. Choose not to disclose
13. Which of the following best describes your gender identity?
    a. Cisgender Female
    b. Cisgender Male
    c. Transgender Female
    d. Transgender Male
    e. Other
    f. Choose not to disclose
14. Which of the following best describes your sexual orientation?
    a. Straight
    b. Bisexual
    c. Gay
    d. Lesbian
    e. Pansexual
    f. Asexual
    g. Queer
    h. Something else
    i. Don't know
    j. Choose not to disclose
15. Do you identify as disabled or chronically ill?
    a. Yes
    b. No
    c. Choose not to disclose
16. Which of the following best describes where you live?
    a. Northside Richmond

b. Southside Richmond
c. East End Richmond
d. West End Richmond
e. Downtown Richmond
f. East Henrico County
g. West Henrico County
h. Chesterfield
i. Other [free response]

Closing

17. This study has multiple phases. Would you like to be contacted about participating in later phases of the study?
    a. Yes
    b. No

Exhibit A6. Birthing Individuals Interview Guide

Introduction: We want to know about how transportation affects access to maternal health services. These services are broadly defined. They could range from clinical appointments to educational classes to grocery stores.

1. To start, generally, what types of transportation do you usually take? How does living in [insert region selected in recruitment survey] affect your access to transportation?
2. Now we want to talk specifically about maternal health services. As an example, let's pretend that you have an appointment today with your obstetrician. Could you walk us through what you would have to do prepare for the appointment and how you would get there?
3. What kinds of services did you use throughout your pregnancy? What about directly after your pregnancy?
    a. [For each service mentioned] What kinds of transportation did you use to access [service mentioned]? How long did it take you to get to [service mentioned]?
    b. Could you tell me a bit more about how transportation availability affected the services you accessed?
    c. What did you like about these modes of transportation? What did you dislike about these modes of transportation?
    d. Did you use any home-based services? [If yes] Why did you use these services?
4. How did your transportation method change throughout your pregnancy? [If applicable] What about after your pregnancy? [If applicable] How did your transportation method change after having more children?
5. What barriers did you encounter with accessing transportation?
    a. Could you tell me more about how you tried to address these barriers?
    b. How do you think these barriers affect your health? What about the health of your child?
        i. What happens if you cannot arrange transportation? What effect does that have on you?
6. What helped you access transportation?
    a. Who, if anyone, helped you access services? How did they help you? [Probe on family members, community-based organizations, and social workers/care coordinators]
    b. [If they received help through organizations or care coordinators] How did you learn about these resources?
    c. How do you think these services affect your health? What about the health of your child?
7. Thinking more broadly, what helps you access services? What keeps you from accessing services?
8. Is there anything else we should know specifically about transportation and accessing services related to maternal health? What about anything else related to accessing services related to maternal health?

Table A1. Strategies for Establishing Trustworthiness (Lincoln & Guba, 1985)

Criteria for Trustworthiness **(Quantitative Analog)**	**Approaches Used to Establish Trustworthiness (Description)**
Credibility (Internal Validity)	• Prolonged Engagement (assists the researcher in testing for misinformation and building trust) • Analyst triangulation (having multiple researchers engaged in collecting and analyzing data) • Member Checking (having participants review the data) • Presentation of Quotes (provides evidence for analytic categories) • Peer Debriefing (having others critically review and discuss the research process and findings)
Transferability (External Validity)	• Demographic Survey (provides a multi-dimensional characterization of participants) • Presentation of Quotes (allows the reader to look for alternate interpretations) • Written Protocols (provides detail of how the study was conducted)
Dependability (Reliability)	• Methodological Journal (provides the documentation as to what and why decisions were made during the conduct of the study) • Audit Trail (provides a way to appraise the replicability of study conclusions)
Confirmability (Objectivity)	• Audit Trail (provides a way to appraise the objectivity of the study conclusions) • Personal Journal (allows the researcher to acknowledge and confront biases and assumptions) • Data Availability (all data were retained)

Appendix B

Table B1. Health Care and Human Services Professionals Sample Demographics (n=20)

	Number (%)
Demographic Information	
Age	
25-34	6 (30)
35-44	8 (40)
45-54	2 (10)
55-64	3 (15)
65+	1 (5)
Ethnicity	
Hispanic or Latinx	2 (10)
Not Hispanic or Latinx	18 (90)
Gender Identity	
Cisgender Female	19 (95)
Cisgender Male	1 (5)
Race	
Black or African American	11 (55)
White	9 (45)
Sexual Orientation	
Bisexual	1 (5)
Straight	17 (85)
Chose Not to Disclose	2 (10)
Organization Information	
Geographic Areas	

Chesterfield	3 (15)
Downtown Richmond	3 (15)
East End Richmond	8 (40)
East Henrico	1 (5)
Northside Richmond	4 (20)
Southside Richmond	6 (30)
West End Richmond	5 (25)
Populations Served	
Black or African American	19 (95)
Hispanic or Latinx	18 (90)
LGBTQ+	1 (5)
Low-Income	20 (100)
Non-English Speaking	16 (80)
Services Offered Across the Maternal Health Continuum	
Preconception/Interconception	14 (70)
Prenatal	17 (85)
Intrapartum/Birth	12 (60)
Postpartum	17 (85)
Early Childhood	2 (10)
Services Provided	
Doula Services	4 (20)
Education	1 (5)
Financial Support	9 (45)
Food Access	5 (25)
Home Visitation	1 (5)
Lactation Support	12 (60)
Mental Health	1 (5)
Midwife Services	4 (20)

Nutrition Education	1 (5)
Primary Care	1 (5)
Resource Referrals	3 (15)
Transportation to Medical Appointments	5 (25)
Support Sources	
Individual Donors	7 (35)
Government Grants	15 (75)
Government-Sponsored Health Insurance	11 (55)
Out of Pocket Individual Payment	8 (40)
Private Health Insurance	5 (25)
Private Organizations	9 (45)
Years Operational	
0-2 Years	1 (5)
3-5 Years	1 (5)
6-10 Years	3 (15)
More Than 10 Years	15 (75)

Table B2. Codebook from Interviews with Health Care and Human Services Professionals

*Unique Patient Work System Sub-Factors Identified

Primary Theme (Deductively Derived)	**Definition**	**Secondary Theme (Inductively Derived)**	**Definition**	**Tertiary Theme (Inductively Derived)**	**Definition**
Person	Relationship between transportation access and characteristics specific to an individual	Biomedical Characteristics	Relationship between transportation access and other medical conditions besides pregnancy		
		Primary Language Spoken	Relationship between transportation access and the dominant language used by a person for communication		
		Socioeconomic Factors	Relationship between transportation access and income level		
Tasks	Relationship between transportation access and the	Coordination	Relationship between transportation access and the level of organization		

	work that needs to be completed		needed to complete a task	
		Difficulty	Relationship between transportation access and the effort required to complete a task	
		Frequency	Relationship between transportation access and the number of times a task needs to be completed in a set period	
Tools and Technology	Relationship between transportation access and available devices or hardware	Car	Relationship between transportation access and a vehicle that carries a small number of passengers	
		Infant Transport Items*	Relationship between transportation access and devices used to move a child from one place to another	

		Communication Technologies	Relationship between transportation access and tools used to send, receive, and process information among people	
		Non-Emergency Medical Transportation*	Relationship between transportation access and vehicles used to carry passengers specifically to clinical services	
		Public Bus	Relationship between transportation access and vehicles used to carry a large number of passengers along a fixed route and schedule	
		Rideshare Services*	Relationship between transportation access and using private	

			transportation operated by a stranger		
Organizational Environment	Relationship between transportation access and organized activities, entities, structures, and policies	Household and Community Settings	Relationship between transportation access and maternal health services in direct or close proximity		
		Operational Dysfunction*	Relationship between transportation access and the ability to provide non-clinical services in accordance with stated policies and structures		
		Policy	Relationship between transportation access and formal rules dictating behaviors	Bringing Children to Clinical Appointments*	Relationship between transportation access and the ability to bring offspring into places providing health care services
				Bus Routes*	Relationship between transportation

					access and set course and frequency of public transportation
				Bus Use*	Relationship between transportation access and rules dictating the utilization of public transportation
				Funding	Relationship between transportation access and financial aid available
				Medicaid Transportation*	Relationship between transportation access and services provided by government-sponsored health insurance
				Running Late to Clinical Appointments*	Relationship between transportation access and procedures for arrivals past an appointment time

				WIC Benefits*	Relationship between transportation access and the need to attend appointments in person to redeem government-sponsored benefits
				Work Leave*	Relationship between transportation access and the ability to take off from employment
Physical Environment	Relationship between transportation access and external conditions	Built Environment	Relationship between transportation access and the availability and condition of structures and systems	Location of Bus Stops*	Relationship between transportation access and determined points for passenger pick up and drop off
				Location of Clinical and Social Services	Relationship between transportation access and the placement of organizations that provide health related services

				Location of Stores	Relationship between transportation access and the placement of retail establishments
				Parking*	Relationship between transportation access and the availability of places to leave a vehicle
				Pedestrian Infrastructure*	Relationship between transportation access and the presence and condition of physical structures for activities such as walking, using a wheelchair, pushing a stroller, etc.
		Weather	Relationship between transportation access and outside conditions		

Social Environment	Relationship between transportation access and other people	Community Networks*	Relationship between transportation access and assistance from people living in the same geographic location	
		Peer Networks*	Relationship between transportation access and assistance from people who have similar experiences	
		Personal Network	Relationship between transportation access and assistance from family and friends	
Outcomes	Relationship between transportation access and resulting impacts	Ability to Access Necessary Items	Relationship between transportation access and the accessibility of needed goods	
		Being Stranded*	Relationship between transportation access and not	

			being picked up by arranged transportation from medical services		
		Effects of Exertion	Relationship between transportation access and the acute impact on health	Mental	Relationship between transportation access and the state of the mind
				Physical	Relationship between transportation access and the state of the body
		Financial Tradeoff*	Relationship between transportation access and having to make monetary sacrifices		
		Missed and Delayed Medical Care	Relationship between transportation access and the inability to access health related services		
		Retention*	Relationship between		

			transportation access and the ability to consistently access services	
		Taking Time Off of Work*	Relationship between transportation access and reduction in hours spent at a job	

Figure B1. Enhanced Patient Work System from Interviews with Health Care and Human Services Professionals

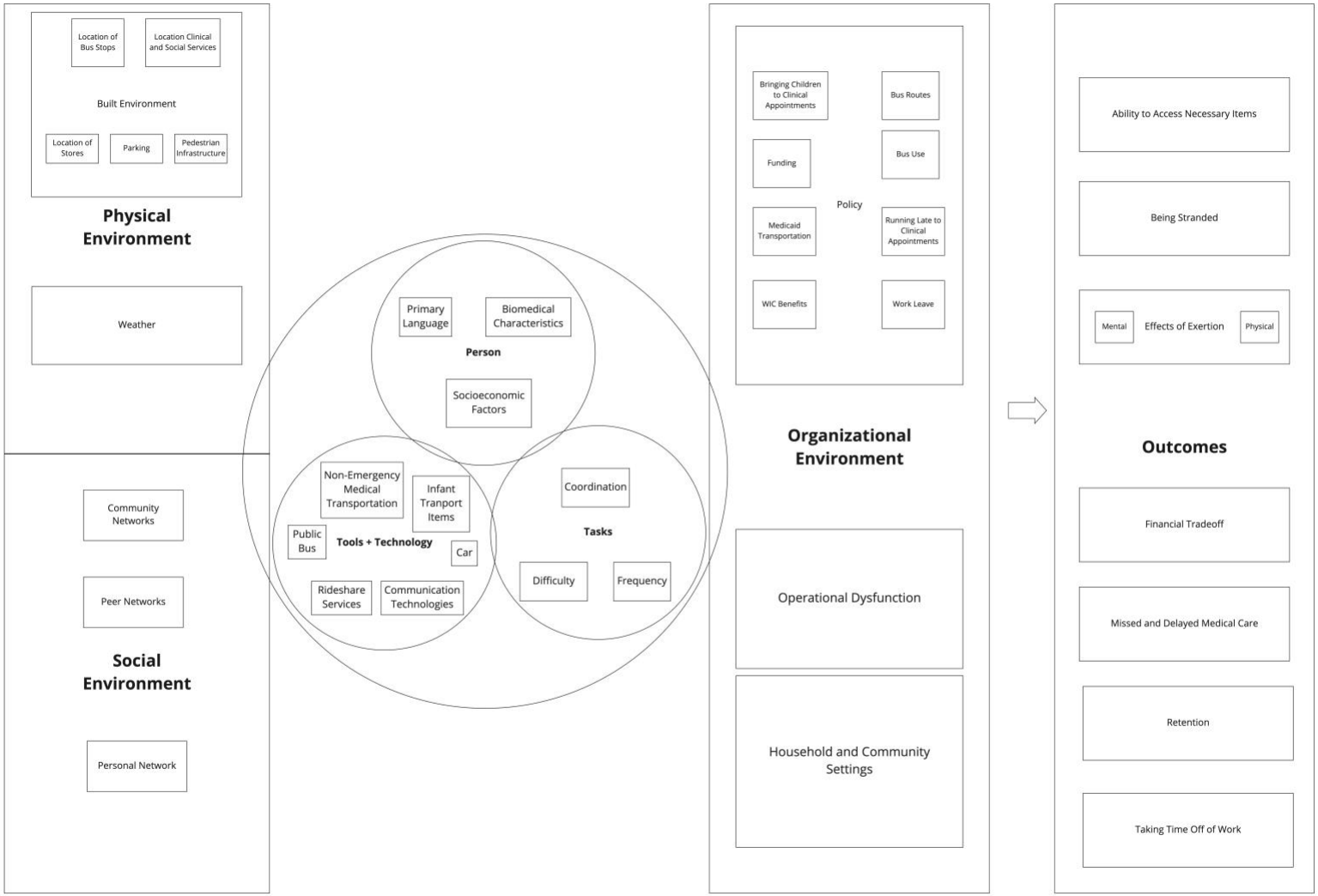


Table B3. Codebook from Systems Mapping with Health Care and Human Services Professionals

Primary Theme	**Definition**	**Secondary Theme**	**Definition**
Interactions	The combined effects of at least two distinct sub-factors on transportation access	Facilitative	Relationship between at least two distinct sub-factors that results in improved transportation access as it relates to a distinct outcome
		Inhibitory	Relationship between at least two distinct sub-factors that results in disrupted transportation access as it relates to a distinct outcome
		Workaround (Inductively Derived)	Approaches used by participants to influence and outcome by changing work system sub-factors

Figure B2. Consolidated Systems Map from Interviews with Health Care and Human Services Professionals

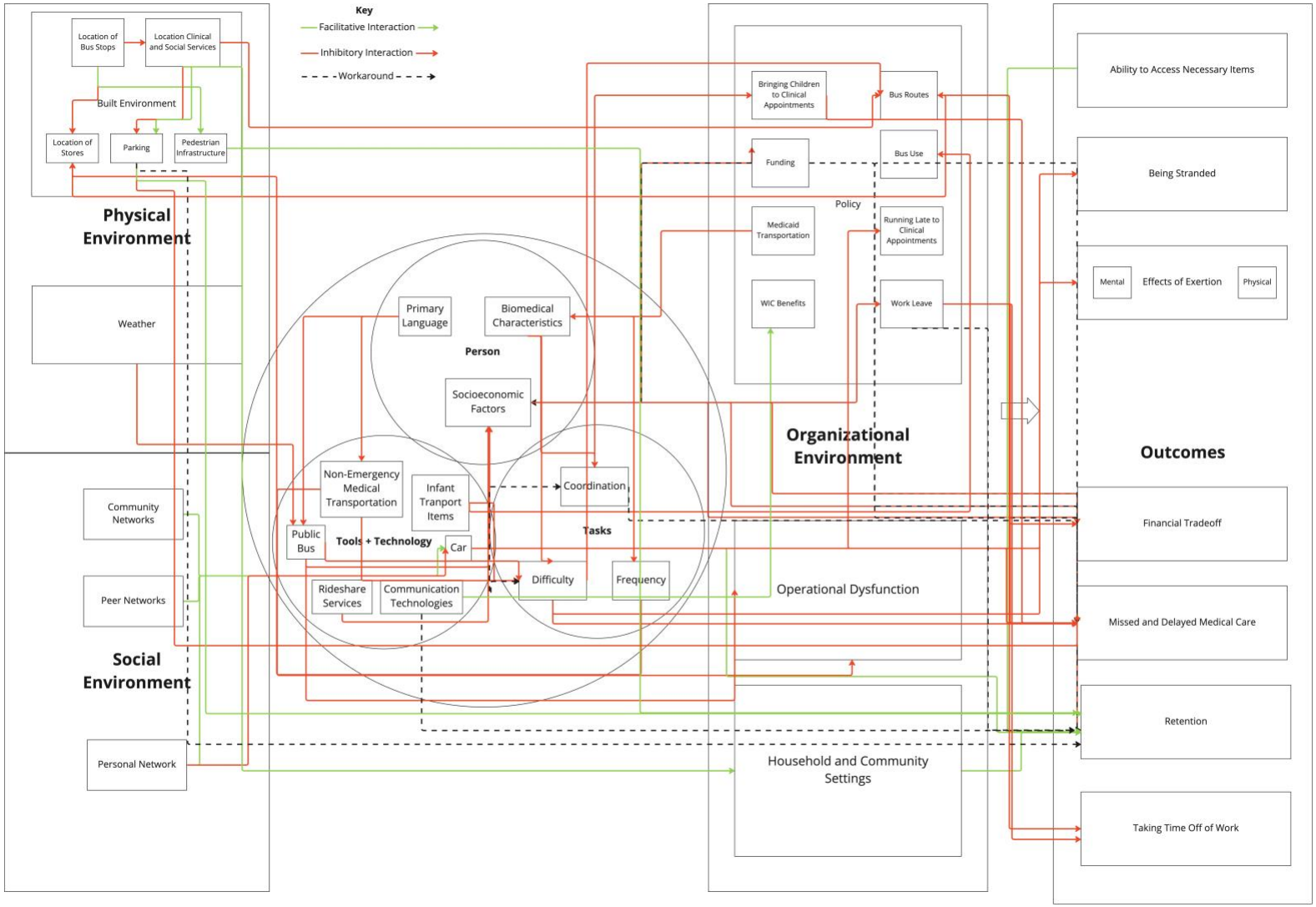
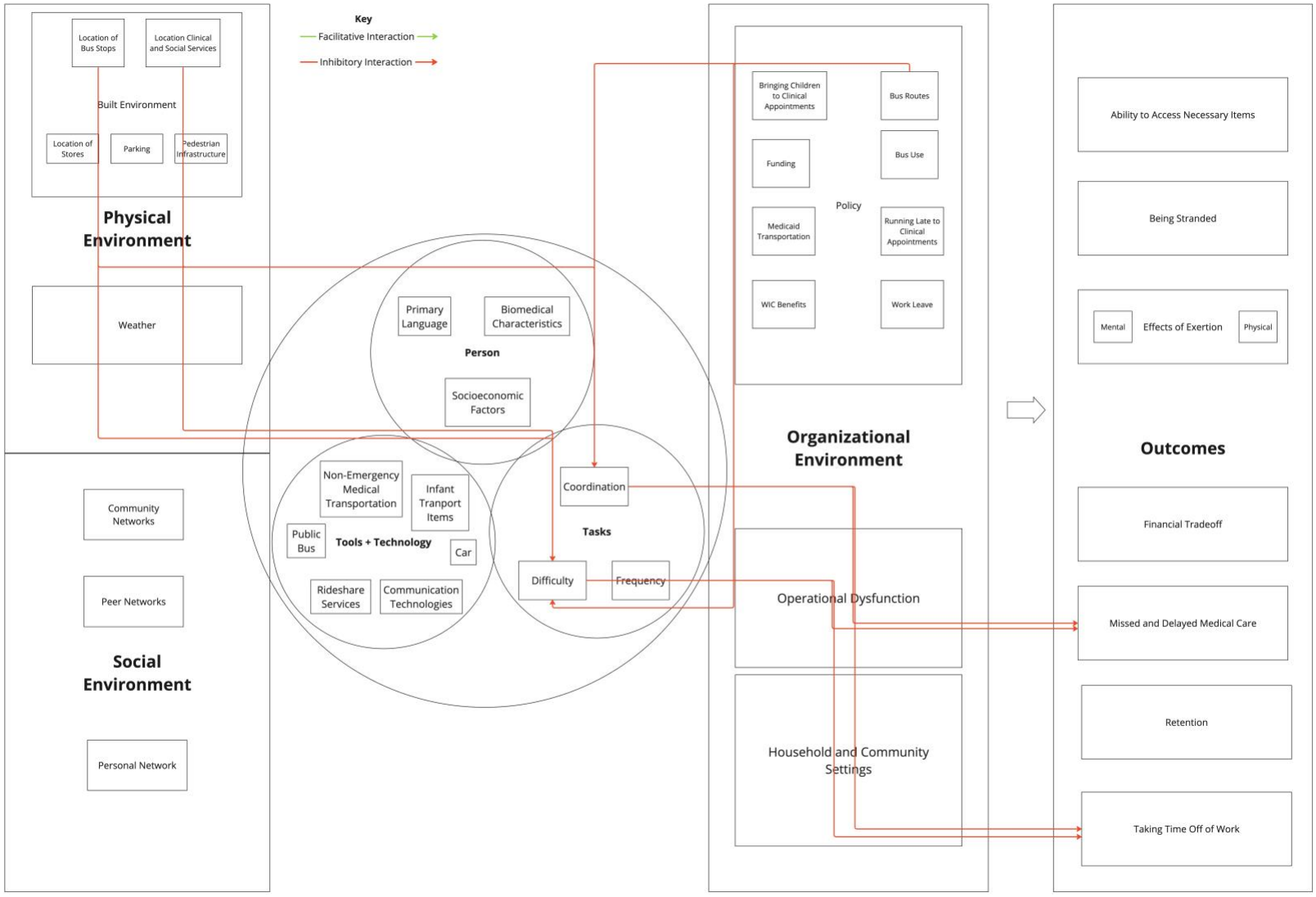


Figure B3. Systems Map from Interviews with Health Care and Human Services Professionals Demonstrating Novel Interactions



Appendix C

Table C1. Birthing Person Sample Demographics (n=18)

	Number (%)
Age	
18-24	4 (22)
25-34	14 (78)
Children	
None (currently pregnant)	2 (11)
1	9 (50)
2	6 (33)
3	1 (6)
Disability Identity	
Disabled or chronically ill	2 (89)
Not disabled or chronically ill	16 (11)
Ethnicity	
Hispanic or Latinx	3 (17)
Not Hispanic or Latinx	14 (78)
Chose not to disclose	1 (6)
Gender Identity	
Cisgender female	16 (89)
Chose not to disclose	2 (11)
Geographic Area	
Northside Richmond	2 (11)
Southside Richmond	6 (33)
East End Richmond	5 (27)
West End Richmond	1 (6)
East Henrico County	3 (17)
Chesterfield	1 (6)

Pregnancy Status	
Currently pregnant	3 (17)
Within the last year	6 (33)
Within the last two years	4 (22)
Within the last three years	2 (11)
Within the last four years	1 (6)
Within the last five years	2 (11)
Race	
Black or African American	18 (100)
Sexual Orientation	
Straight	17 (94)
Lesbian	1 (6)

Table C2. Codebook from Interviews with Birthing Persons

*Unique Patient Work System Sub-Factors Identified

Primary Theme (Deductively Derived)	**Definition**	**Secondary Theme (Inductively Derived)**	**Definition**	**Tertiary Theme (Inductively Derived)**	**Definition**
Person	Relationship between transportation access and characteristics specific to an individual	Biomedical Characteristics	Relationship between transportation access and other medical conditions besides pregnancy		
		Discomfort with Rideshare Services*	Relationship between transportation access and concerns about using private transportation operated by a stranger		
		Experience of Pregnancy*	Relationship between transportation access and physiological changes during and after being pregnant		
		Socioeconomic Factors	Relationship between		

			transportation access and income level	
Task	Relationship between transportation access and the work that needs to be completed	Coordination	Relationship between transportation access and the level of organization needed to complete a task	
		Difficulty	Relationship between transportation access and the effort required to complete a task	
		Duration	Relationship between transportation access and the number of times a task needs to be completed in a set period	
		Frequency	Relationship between transportation access and the number of times a task needs to be	

			completed in a set period	
		Routinization	Relationship between a transportation access and comfort with familiar tasks	
Tools and Technology	Relationship between transportation access and available devices, software, or hardware	Car	Relationship between transportation access and a vehicle that carries a small number of passengers	
		Infant Transport Items*	Relationship between transportation access and devices used to move a child from one place to another	
		Internet	Relationship between transportation access and information hosted on electronic networks	
		Non-Emergency Medical Transportation*	Relationship between transportation	

			access and vehicles used to carry passengers specifically to clinical services	
		Public Bus	Relationship between transportation access and vehicles used to carry a large number of passengers along a fixed route and schedule	
		Rideshare Services*	Relationship between transportation access and using private transportation operated by a stranger	
		Smartphone	Relationship between transportation access and a mobile device that performs the actions of a computer	

Organizational Environment	Relationship between transportation access and organized activities, entities, structures, and policies	Household and Community Settings	Relationship between transportation access and maternal health services in direct or close proximity	Midwifery Services	Relationship between transportation access and those trained to assist during childbirth
				Non-profit Organizations	Relationship between transportation access and entities that provide services for the common good
		Operational Dysfunction*	Relationship between transportation access and the ability to provide non-clinical services in accordance with stated policies and structures		
		Policy	Relationship between transportation access and formal rules dictating behaviors	Bringing Children to Clinical Appointments*	Relationship between transportation access and the ability to bring offspring into places providing health care services

				Bus Routes*	Relationship between transportation access and set course and frequency of public transportation
				Funding	Relationship between transportation access and financial aid available
				Mask Mandates*	Relationship between transportation access and requirements to wear face coverings to mitigate the transmission of airborne diseases
				Medicaid Transportation*	Relationship between transportation access and services provided by government-sponsored health insurance

				Running Late to Clinical Appointments*	Relationship between transportation access and procedures for arrivals past an appointment time
				WIC Benefits*	Relationship between transportation access and the need to attend appointments in person to redeem government-sponsored benefits
				Work Leave*	Relationship between transportation access and the ability to take off from employment
		Scheduling*	Relationship between transportation access and on health system operations and logistics		
Physical Environment	Relationship between	Built Environment	Relationship between	Bus Stop Shelters*	Relationship between

	transportation access and external conditions		transportation access and the availability and condition of structures and systems		transportation access and structures to safeguard passengers
				Location of Bus Stops*	Relationship between transportation access and determined points for passenger pick up and drop off
				Location of Clinical and Social Services	Relationship between transportation access and the placement of organizations that provide health related services
				Location of Recreational Places	Relationship between transportation access and the placement of areas and establishments for leisure activities
				Location of Stores	Relationship between transportation

					access and the placement of retail establishments
				Parking*	Relationship between transportation access and the availability of places to leave a vehicle
				Pedestrian Infrastructure*	Relationship between transportation access and the presence and condition of physical structures for activities such as walking, using a wheelchair, pushing a stroller, etc.
		Weather	Relationship between transportation access and outside conditions		
Social Environment	Relationship between transportation access and other people	Culture	Relationship between transportation access and the norms and practices	Discrimination*	Relationship between transportation access and the unjust or prejudicial treatment of

			of a particular group of people		different categories of people
		Personal Network	Relationship between transportation access and assistance from family and friends	Childcare	Relationship between transportation access and the care and supervision of offspring
				Direct Transportation Assistance	Relationship between transportation access and providing a ride with or loaning a personal vehicle
				Indirect Transportation Assistance	Relationship between transportation access and picking up and delivering items
		Strangers in Public Spaces*	Relationship between transportation access and unfamiliar people in common areas		
Outcomes	Relationship between transportation	Ability to Access Necessary Items	Relationship between transportation	Food Availability	Relationship between transportation

	access and resulting impacts		access and the accessibility of needed goods		access and the accessibility of nutritious and affordable food
				Infant Care Item Availability*	Relationship between transportation access and the accessibility of items needed specifically for babies
		Assuming Risks*	Relationship between transportation access and voluntarily exposing oneself to known danger	Exposure to Hazardous Road Conditions*	Relationship between transportation access and dangerous traffic environments
				Exposure to Infectious Diseases*	Relationship between transportation access and assuming risk of contracting a communicable illness
				Threats to Personal Safety*	Relationship between transportation access and harmful situations

					intentionally created by others
		Being Stranded*	Relationship between transportation access and not being picked up by arranged transportation from medical services		
		Effects of Exertion	Relationship between transportation access and the acute impact on health	Mental	Relationship between transportation access and the state of the mind
				Physical	Relationship between transportation access and the state of the body
		Financial Tradeoff*	Relationship between transportation access and having to make monetary sacrifices		
		Missed and Delayed Medical Care	Relationship between transportation		

			access and the inability to access health related services	
		Medical Negligence*	Relationship between transportation access and failure of health care professionals to perform duties in line with best practice	
		Taking Time Off Work*	Relationship between transportation access and reduction in hours spent at a job	

Figure C1. Enhanced Patient Work System from Interviews with Birthing Persons

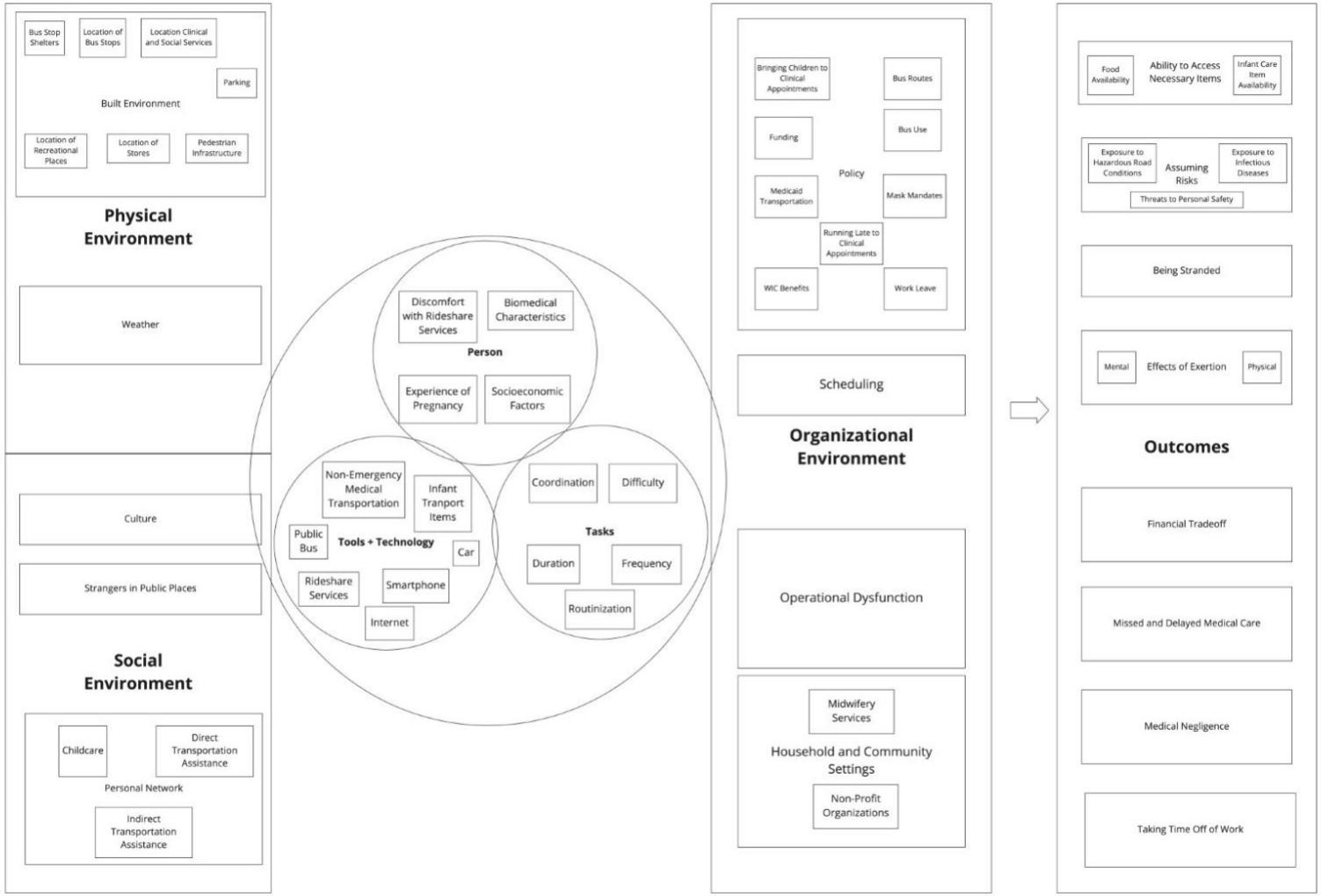


Table C3. Codebook from Systems Mapping from Interviews with Birthing Persons

Primary Theme	**Definition**	**Secondary Theme**	**Definition**
Interactions	The combined effects of at least two distinct sub-factors on transportation access	Facilitative	Relationship between at least two distinct sub-factors that results in improved transportation access as it relates to a distinct outcome
		Inhibitory	Relationship between at least two distinct sub-factors that results in disrupted transportation access as it relates to a distinct outcome

Figure C2. Consolidated Systems Map from Interviews with Birthing Persons

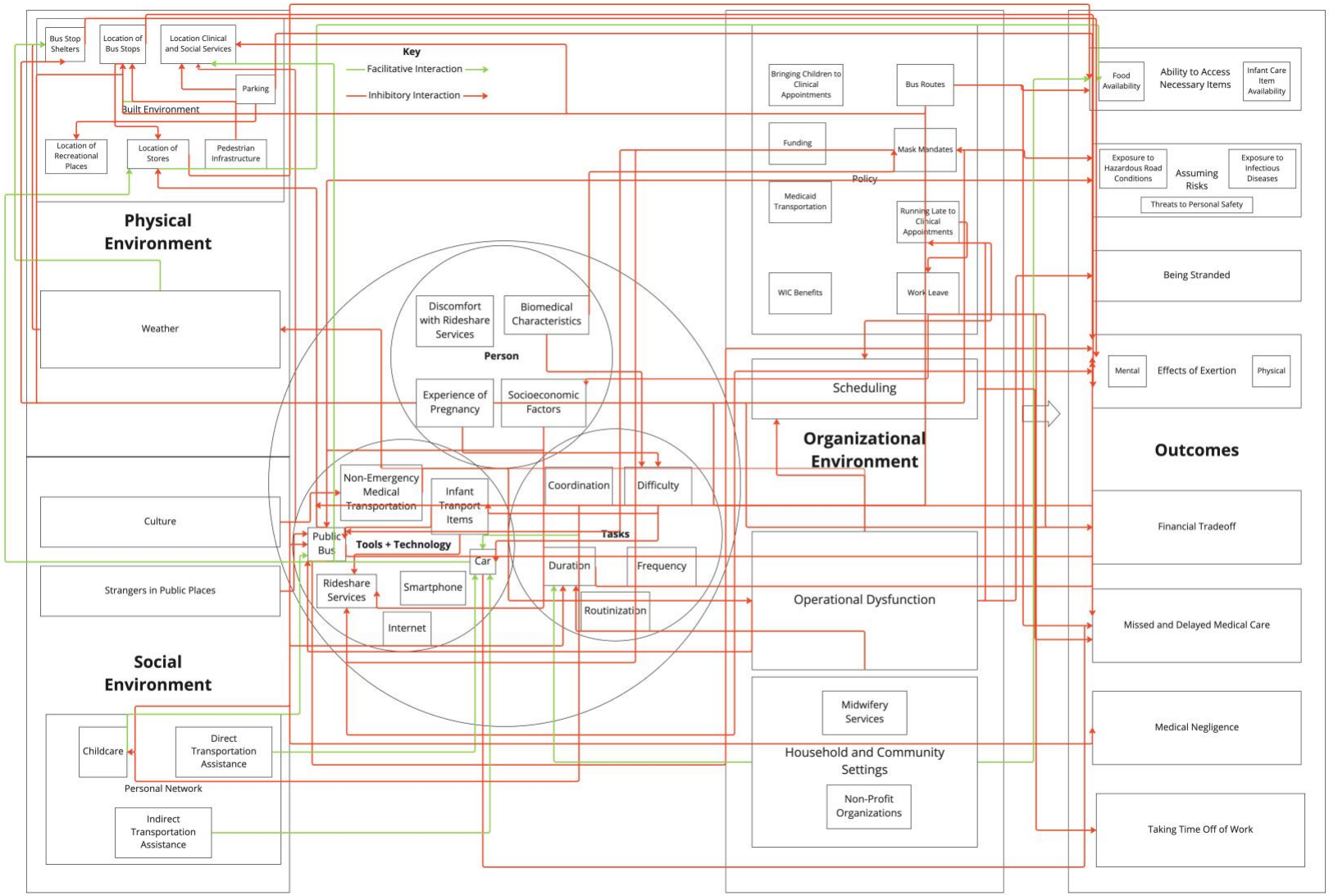
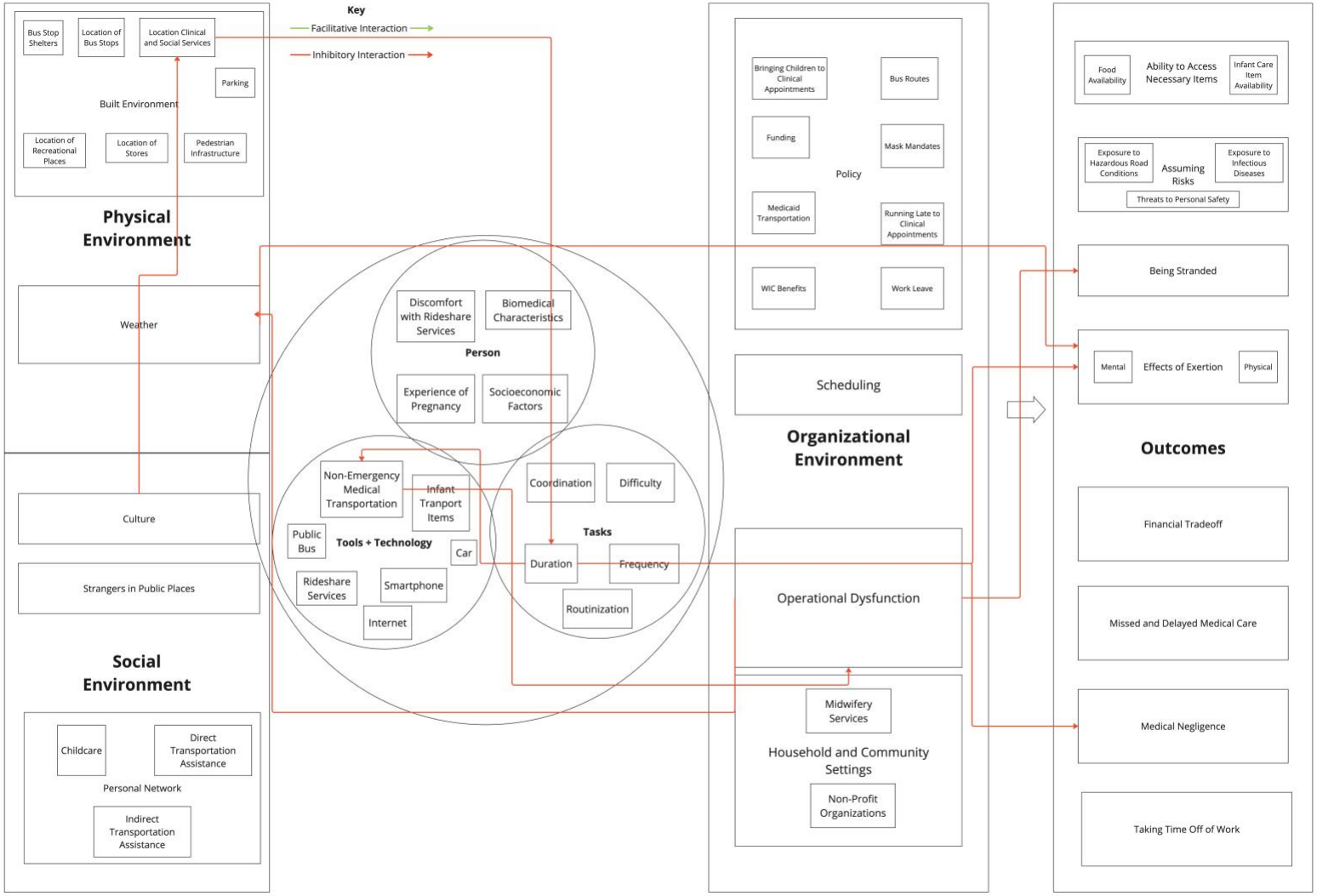


Figure C3. Systems Map from Interviews with Birthing Persons Demonstrating Novel Interactions



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