EXAMINING THE ROLE OF WORK DOMAINS AND JOB STRAIN ON PRETERM BIRTH AMONG BLACK MOTHERS

By

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ABSTRACT

Background and Objectives: Preterm birth (PTB) contributes substantially to neonatal mortality, morbidity, and long-term neurological disabilities. While many potential risk factors for PTB have been extensively studied, workplace exposures and experiences during pregnancy have rarely been studied, especially among Black women. My dissertation aimed to 1) evaluate the associations between multiple dimensional work exposures (work hours, physical demands, psychological demands, job strain) and PTB, 2) determine if psychosocial factors (social support, depressive symptoms, stress) and lifetime experiences of racism moderate the associations. Methods: Using cohort data of Black women residing in Baltimore, we conducted a within-group analysis restricted to the 429 women employed during pregnancy. We used log-binomial regression analyses to determine the role of work exposures on PTB risk and to adjust for the potential covariates. We conducted moderation analyses on a multiplicative scale by adding an interaction term between the work exposure and the potential moderator to the adjusted regression models. We determined the significance of the interaction terms using the Likelihood Ratio (LR) chi-square test and a p-value less than 0.10. Results: Positive associations between PTB and prolonged working hours (aPR = 1.56; 95% CI: 0.75, 3.24), lifting heavy loads (aPR = 1.33; 95% CI: 0.88, 2.00). Working with physically awkward body positions was associated with lower PTB rates (aPR = 0.67; 95% CI: 0.43,1.07). Highest psychologically demanding work (top quartile vs. lower three quartiles) was significantly associated with PTB (aPR = 1.82; 95% CI: 1.20, 2.76). Modest PTB associations were observed with jobs that required an excessive amount of work (aPR=1.32; 95% CI: 0.84,2.07) or not having enough time to complete

work (aPR=1.49; 95% CI: 0.92,2.42). We observed modest associations with PTB for women with high strain (aPR=1.47; 95% CI: 0.80,2.72), active (aPR=1.42; 95% CI: 0.76,2.66), and intermediate strain jobs (aPR=1.36; 95% CI: 0.81,2.27). Women enrolled postpartum had elevated PTB rates when working longer hours (aPR= 2.65; 95%CI: 1.00,7.01). Evidence of moderation by psychosocial factors for the PTB work exposure associations. High physically demanding work was associated with high PTB rates among women with low social support (aPR:1.90; 95% CI: 0.94,3.85). High psychologically demanding work was significantly associated with increased PTB rates among women with low social support (aPR: 1.92; 95% CI: 1.16, 3.17) and high depressive symptoms (aPR: 1.99; 95% CI: 1.12, 3.52). Among women with low social support, active (aPR: 2.47; 95% CI:1.12,5.44), high strain jobs (aPR: 2.05; 95% CI:0.93,4.53) were associated with increased PTB rates. Among women with high depressive symptoms, active (aPR: 3.10; 95% CI:1.07,8.98) and high strain jobs (aPR: 3.59; 95% CI:1.28,10.05) and passive jobs (aPR: 2.32; 95% CI:0.78,6.89) were associated with increased PTB rates. Conclusion: Physically demanding work activities may increase PTB rates in Black women, with evidence of interactions with social support. Black women with psychologically demanding work activities are at elevated risk of PTB, with evidence of interactions with psychosocial factors. PTB rates were elevated for women with active and high strain jobs after considering psychosocial factors. Evidence of interactions between the work exposures and psychosocial factors suggests that impacts are intertwined. Findings underscore the importance of implementing policies and measures that foster a supportive work environment for pregnant women to ensure better pregnancy outcomes.

I dedicate this work to my lovely husband, Dr. Allan Kizza Nkwata, my daughters Alicia and Felicia, and my son Isaiah. Thank you for being a constant source of support and encouragement throughout this journey.

“He has made everything beautiful in its time. Also, he has put eternity into man’s heart, yet no one can fathom what God has done from the beginning to the end.”
Ecclesiastes 3:11

“For I know the plans I have for you,” declares the LORD, “plans to prosper you and not to harm you, plans to give you hope and a future.”
Jeremiah 29:11

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CHAPTER 1: INTRODUCTION

1.1 Overview

In the US, Black women are almost twice as likely as Non-Hispanic White women to experience preterm birth(PTB; <37 weeks gestation; 14.6% vs. 9.4% in 2022),[1,2] which is the leading cause of infant mortality among Black infants.[3] While many potential risk factors for PTB in the prenatal and even pre-conceptional environment have been extensively studied, workplace exposures and experiences during pregnancy have rarely been studied. Such work has been even less frequent in large epidemiologic or clinical studies of preterm birth among Black women. While U.S. women have always been part of the workforce,[4–6] the proportion of women employed has risen, and most women continue working throughout pregnancy.[7–9] Work provides benefits (i.e., income, personal fulfillment, insurance, and paid leave). However, working during pregnancy can have physical and psychological stressors that may increase the risk for PTB. Pregnant women may also experience job strain in the workplace, a form of psychosocial stress due to workload demands, lack of independence in their tasks, not being part of decision-making, and discrimination in such spaces.[10] Additionally, while psychosocial factors (e.g., social support, stress, depression) and racism are well-established risk factors for PTB,[11,12] how they relate to other stressors and conditions specific to the workplace has been little examined. These factors could amplify or buffer workplace exposures.

This dissertation investigates how exposures in the work environment relate to adverse birth outcomes in a high-risk population of Black women, a group that is

disproportionately affected by poor birth outcomes. The specific aims of this dissertation will examine the relationship between multiple domains of work, job strain, and PTB among Black women:

Specific Aim 1: Evaluate the associations between multiple domains of work (i.e., number of hours of work, physical demands, psychological demands) and preterm birth.

Hypothesis: Preterm birth will be elevated in pregnant women who are 1) working for prolonged hours (> 40 hours per week) and 2) involved in physically and psychologically demanding work activities.

Specific Aim 2: Evaluate the impact of job strain on the risk of preterm birth.

Hypothesis: The risk of preterm birth will vary by job strain. We will compare preterm birth risk by four categories: high strain (low control, high demands), active (high control, high demands), passive (low control, low demands), and low strain (high control, low demands).

Specific Aim 3: Evaluate whether the association between work exposures (work domains, job strain) and PTB differs according to social support, depressive symptoms, perceived stress, and lifetime experiences of racism.

Hypothesis: The impact of work on PTB will be stronger among pregnant women: 1) with lower vs. higher social support; 2) with more vs. fewer depressive symptoms; 3) with higher vs. lower stress; and 3) higher vs. lower lifetime experiences of racism.

This research will greatly contribute to the scientific knowledge regarding the exposures in prenatal and pre-conceptional environments that are key drivers of the persisting disparities in pregnancy outcomes.

1.2 Significance

1.2.1 Scientific significance

This work is significant in that it provides novel empirical evidence on the role of multi-dimensional work exposures on preterm birth among Black mothers. This information can aid in developing workplace policies that support the health of pregnant women and infants.

1.2.2 Public health significance

Black families are disproportionately affected by PTB.[2] While many aspects of the prenatal and even pre-conceptional environment have been extensively studied, prenatal workplace exposures and experiences have rarely been studied among Black women who are at elevated risk of PTB. This work is relevant to public health as it will inform whether specific workplace exposures increase the risk of PTB and among which subgroups of Black women. The information from this research can be leveraged to educate pregnant women about work-related factors that may increase their risk of PTB. However, it is worth noting that workforce inequities result from multiple factors, such as education and socioeconomic status, which are themselves independent risk factors for PTB. Developing interventions that reduce preterm birth in high-risk populations will further progress towards achieving lower rates of preterm birth at a national level. This work will highlight the need for social and economic policies to improve the livelihood of pregnant women in the workforce. Some accommodations that may be helpful for pregnant women include, but are not limited to, flexible working hours and switching heavy, demanding tasks for lighter ones. Furthermore, the findings from this research may provide guidance for the development of interventions that enhance stress management, which may be particularly beneficial for pregnant women in the workforce.

1.3 Dissertation Organization & Overview

This dissertation has been organized into seven chapters. Chapter 1 provided an overview of the dissertation objective, specific aims, and scientific and public health significance. Chapter 2 provides relevant background information and literature on PTB, as well as exposure and experiences in the workplace environment. Chapter 3 will cover an overview of the approach, and details will be provided in Chapters 4 through 6 in each individual manuscript. Chapters 4 through 6 will provide more details and address the three specific aims, presenting three publishable manuscripts with standalone abstracts, introductions, methodologies, results, discussions, conclusions, and references. Chapter 7 will summarize the major findings and provide the discussion and implications of the research.

CHAPTER 2: BACKGROUND

2.1 Overview of preterm birth

Preterm birth (PTB) is a major obstetric problem contributing to most neonatal mortality, morbidity, and long-term neurological disabilities.[13] Very PTB (28 to less than 32 weeks of gestational age) accounts for most neonatal deaths and disabilities,[14,15] and spontaneous PTB accounts for most preterm births, possibly due to women experiencing early labor or untimely rupture of membranes.[16] In addition, physicians initiate other types of PTB due to maternal or fetal complications.[17] Regardless, surviving infants are at increased risk of cerebral palsy, developmental delays, vision and hearing problems, and cardiovascular disease during adulthood.[18–21] Annually, PTB affects nearly 15 million babies born globally, with a tremendous burden experienced by less developed countries.[22] In the United States (US), PTB affects 1 of every 10 (10.4%) infants born annually,[18,22] which is higher than other industrialized countries (i.e., UK, Canada, Australia, Japan), ranging from 5.7-8.6%.[23,24] Further, Black women are 1.6 times more likely to experience PTB compared with white women, and PTB is the leading cause of infant mortality among Black infants in the US.[2] While maternal characteristics like education, socioeconomic status, and smoking have been identified as risk factors for PTB, these factors do not explain the disproportionate effect of PTB on Black women, supporting the need to explore other factors.

2.2 Working during pregnancy

U.S. women have always worked, particularly Black and immigrant women who worked for survival before paid work became the norm in society.[4–6] Increases in the

employment rates among higher income and higher education white women, including women with children, started accelerating in the 1970s.[25] The proportion of women employed has risen to 56.1%,[26] and most continue working throughout pregnancy.[8,9] Women work during pregnancy for a range of reasons. Work provides benefits (i.e., income, personal fulfillment, insurance, and paid leave), which they may have to forfeit if they opt out of employment. Yet, employment during pregnancy can have both physical and psychological dimensions that may increase some workers' preterm birth risk. Pregnant women may also experience job strain in the workplace, a form of psychosocial stress due to workload demands, lack of independence in their tasks, not being part of decision-making, and discrimination in such spaces.[10]

2.2.1 Occupational regulations to accommodate working during pregnancy

Most developed countries have had clear national guidelines and leave programs to ensure the well-being of pregnant women in workplaces. However, the United States has lacked such guidelines and programs for decades, and pregnant women have experienced discrimination in the workplace.[27] During the 1950s during laws were enacted in some states which protected workers by requiring r a minimum hourly wage and a maximum number of weekly hours worked. However, neither state nor federal legislators proposed any steps to protect pregnant employees from discrimination.[28] The passage of Title VII of the Civil Rights Act in 1964 prohibited employers from discriminating against employees based on sex, race, color, national origin, and religion. Yet even this wide ranging act did not include pregnant women as a class. Pregnant women could be excluded from benefits or forced to choose between their jobs and pregnancy, and legislators were faced with a choice of whether to protect pregnant women or employers.[29,30] Further, workplaces like secondary schools often

discriminated against pregnant women once their pregnancy was visible, claiming the need to protect the mother's health and the continuity of students' education.[31] Worth noting is that the Equal Employment Opportunity Commission (EEOC) did not initially treat maternity as other temporary disabilities under Title VII until guidelines were updated in 1972.[32]

Controversies regarding how Title VII applied to pregnant workers led to the passage of the Pregnancy Discrimination Act of 1978 (PDA). The PDA makes it unlawful for companies with 15 or more employees to consider pregnancy in hiring, firing, or promotion decisions, and requires equal treatment for all workers. Employers were also required to offer equal treatment for all workers and cover pregnant women in their disability benefits.[33] However, some employers contested the PDA, which led to the passage of the Family Medical Leave Act (FMLA) of 1993. FMLA provides employees in companies with 50 or more employees up to 12 weeks of unpaid leave over 12 months. However, only a small percentage of pregnant women in the workforce benefit from the FMLA, and the eligibility of those who work for such companies is determined by being employed by such a company for one or more years. FMLA also does not address hazards specific to pregnancy in the workplace.

The most recent update has been the passage of the Pregnant Workers Fairness Act (PWFA), which requires employers to provide reasonable accommodation for pregnancy, childbirth, or related medical conditions, unless it causes undue hardship. This ensures pregnant employees can continue working with necessary adjustments rather than being forced to take leave. This act applies to private employers, public sector employers, Congress, federal agencies, employment agencies, and labor

organizations with 15 or more employees. Some of the accommodations may include flexible breaks (rest, restroom use, drinking water, eating); moderated work duties (switching strenuous activities to light duties); schedule adjustment (flexible work hours, flexible schedule to accommodate prenatal visits); seating accommodation (chairs or stools); temporary transfer to less physically, psychologically demanding duties; remote work as needed. Our dissertation findings will provide evidence to support the implementation of accommodations in the workplace that align with the PWFA, hence improving the livelihood of pregnant women and ensuring better pregnancy outcomes.

2.3 Karasek Job Demand Control Model and questionnaire

The Karasek job demand control model is a theoretical framework[34] applied to the relationship between job strain and health outcomes such as cardiovascular disease.[35] This model is pertinent to this dissertation work as its concepts are vital for workers, including pregnant women who work through pregnancy. The model focuses on assessing the stress that employees face in their workplace. The Karasek model assumes that psychological stress results from the joint effects of work demands and the flexibility an individual has to make decisions in a workplace.[36] Using this theoretical framework, we can make plausible links between work-related stress and preterm birth. Most studies that have examined the effect of job strain on preterm birth have utilized the median score approach to create four categories of job strain: low strain jobs (low demands and high control), passive jobs (low demands and low control), active (high demands and control) and high strain (high job demands with low control). Low-strain jobs (e.g., Teachers, hairdressers, and engineers) include duties with low demand, and employees can choose their schedules. High strain jobs (e.g., Nursing aides, cleaners,

dental assistants, telephone operators, waitresses, and sewing machine operators) are usually very demanding, and employees have limited control. Such jobs usually lead to high stress.[37] Passive jobs (e.g., clerical workers, bank assistants, and laboratory workers) are typically simple duties without a decision-making component and have the minimum risk of stress. Active jobs (e.g., professors, teachers, journalists) can be very demanding, but they allow employees to decide their schedules. As a result, they are not perceived as stressful jobs but opportunities for new challenges that foster progress.[34]

2.4 Work exposures and preterm birth

2.4.1 Prolonged work hours and preterm birth

As women continue working through pregnancy, some work longer than the standard 8 hours, especially those with extended shifts and those who work multiple jobs. It is worth noting that some women may have additional tasks outside the workplace that they have to accomplish daily within their homes. Previous studies have examined the association between long work hours and PTB.[38–51] Findings from these studies have been inconsistent as some have reported significant associations between long working hours and PTB[42,46–50] while others have reported no significant association.[39–41,43,44]

2.4.2 Physical demands and preterm birth

While leisure time physical activity appears to reduce the risk of PTB,[52] physical activity in a work environment may not necessarily be beneficial. Work activity may be more physically demanding and endured for 8 hours or longer for women with extended shifts or who work multiple jobs. Findings are inconsistent in existing reports on the relationship between the physical demands of work and PTB.[39,42,44,46,50,53–59] Some

studies showed an increased risk of PTB with selected work exposures (e.g., heavy lifting[53,59]; demanding body posture[39,46]; occupational physical activity[55]). Others detected no significant association between work exposures (e.g., physically demanding work[59]; physical workload[44]) and PTB. Two studies reported that working during pregnancy offered a protective effect on the risk of PTB.[54,58]

2.4.3 Psychological demands and preterm birth

Working during pregnancy can expose women to psychosocial stresses in the work environment that may increase the risk of PTB for some women. In non-pregnant individuals, prior studies have investigated the effect of the psychosocial stresses of the work environment on hypertension, cardiovascular disease,[61–64] and musculoskeletal disorders.[65,66] The role of psychological demands of the work environment on PTB risk has been little examined. Only two studies, Escriba-Aguir et al. in a case-control study[40] and Meyer et al. in a US cross-sectional study,[67] considered the effect of psychological demands of the work environment on PTB separate from the worker's control. Furthermore, no published studies have examined the effect of psychological demands on PTB among Black women. Meyer et al. included data for Black women in his study; however, the authors did not report on the effect of psychological demands on PTB but considered race as a confounder.

2.4.4 Job strain and preterm birth

Pregnant women may also experience job strain in the workplace, a form of psychosocial stress due to workload demands, lack of independence in their tasks, not being part of decision-making, and discrimination that may happen in such spaces.[10] Outside of pregnancy, job strain impacts physical and psychological health and increases the risk of chronic hypertension and coronary heart disease.[68,69] Among

pregnant women, only a small number of studies have examined the effect of job strain on PTB.[44,46,67,70–75] Of these studies, only three were from the US[67,71,73] while the other studies were from Denmark,[72,74,75] the Netherlands,[44] Canada,[46] and Mexico.[70] The findings from these studies have been inconclusive as some have reported elevated risk of PTB with job strain[46,67,71,73] while others have reported no association.[70,74]

In summary, findings are inconsistent in existing reports on the relationship between workplace exposures (work hours, physical demands, psychological demands, job strain) and preterm birth.[38–44,46–51,53–59,67,70–80] Two were retrospective cohorts,[48,49] fifteen were prospective cohorts,[39,41,43,44,50,51,53,58,59,71,74–77,79] ten were case-control[38,40,42,46,55,72,73,78,80,81] and three were cross-sectional.[47,54,67,70] In most of these studies, recruitment occurred during prenatal care with exposure assessment based on the early part of the pregnancy. Some studies evaluated multiple work exposures, while others focused on a single exposure. Measures for work exposures were variable, i.e., using single items rather than scales to assess workplace conditions or experiences.[39,46,55,82] Findings have been mixed. Some studies showed an increased risk of PTB with selected work exposures (heavy lifting[53,59]; prolonged work hours[42,46–50]; demanding body posture[39,46]; occupational physical activity[55]; job strain[46,67,71,73]). Others showed no significant association between work exposures (physically strenuous work[59]; physical workload[44]; job strain[44]; prolonged work hours:>=40 hrs/week[39–41,43,44]; psychological demands[40,67]; job strain[70,74]) and PTB, while Pompeii et al.[58] reported a protective effect on PTB risk for women who worked 46 or more hours per week.

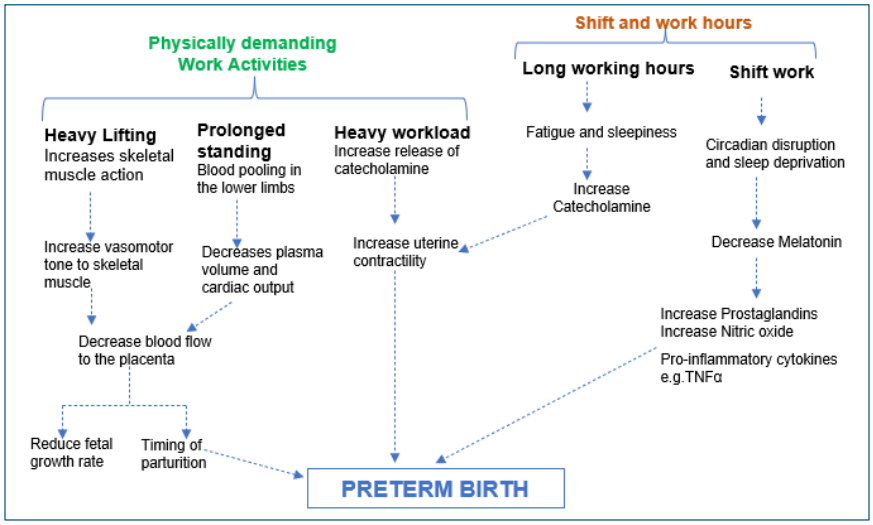
Only nine existing reports [51,55,58,67,71,73,77–79] that have examined the work exposure-PTB association were from the U.S. and included Black women. Of the U.S.

studies, Brett et al.,[73] and Bell et al.,[77] evaluated the impact of work exposures on PTB among Black women**.** Six other studies controlled for race as a confounder,[55,58,67,71,78,79] while Lawson[51] did not report on association by race or control for race as a confounder.

2.5 Potential mechanisms for the work exposures-PTB associations

Evidence shows several mechanisms that could explain the association between work exposures and preterm birth. During heavy lifting, there is an increase in vasomotor tone to skeletal muscle [83] which reduces the blood flow to the placenta and may lead to PTB.[77] Further, physically demanding work activities may increase norepinephrine levels which may lead to uterine contractility and PTB.[9] Furthermore, as pregnant women work long hours, there is an increase in catecholamine levels, which may increase uterine contractility[84] and may lead to PTB.[85](**Figure 1**)

Figure 1: Potential mechanisms for the impact of work exposures on preterm birth



In addition, high strain jobs (high demand and low control) may increase catecholamine levels, which have been linked to hypertension, both of which may increase the risk of PTB.[86–89] Further, high strain jobs may trigger behavioral coping mechanisms like smoking in some women, hence increasing their risk for PTB.[90,91]

2.6 Research gaps

In summary, conflicting results exist on the impact of work exposures on the risk of PTB. Some studies have shown a high risk of PTB, while others show no association. Furthermore, there are important gaps in prior work. First, only two of the studies[73,77] that included Black women evaluated the impact of work exposures on PTB, while the rest of the studies controlled for race as a confounder.[55,58,67,71,78,79] Evidence shows that minority populations are disproportionately affected by PTB. While many aspects of the prenatal and even pre-conceptional environment have been extensively studied, workplace exposures and experiences during pregnancy have rarely been studied among Black women who are at elevated risk of PTB. We will address this gap by analysis of our large Black only cohort and by the inclusion of exposures unique to Black women, chiefly racism. Second, while psychosocial factors (e.g., stress, depressive symptoms) and lifetime experiences of racism have been studied outside the workplace environment and found to relate to the risk of PTB, how they relate to stressors and conditions specific to the workplace has been little examined. These factors could amplify or buffer workplace exposures. Prior reports of the North Carolina cohort examined moderation by race but not by racism or other factors.[58,73] This dissertation work is significant because it provides novel empirical evidence on the role of multi-dimensional work exposures on preterm birth among Black mothers. This information can aid in developing workplace policies to support the health of pregnant women and infants.

To our knowledge, this dissertation work is the first to evaluate the association between multi-dimensional work exposures and PTB in Black women. This work is the

second to utilize the JDC[34] to examine job strain among pregnant Black women. Another unique aspect of our work is the evaluation of the potential moderating role that social support, depressive symptoms, stress, and lifetime experiences of racism may have on the association between multidimensional work exposures and PTB. The vulnerability of Black women to adverse working conditions may be heterogeneous, as has been reported for the effects of racism and PTB.[92,93]

CHAPTER 3: METHODOLOGY

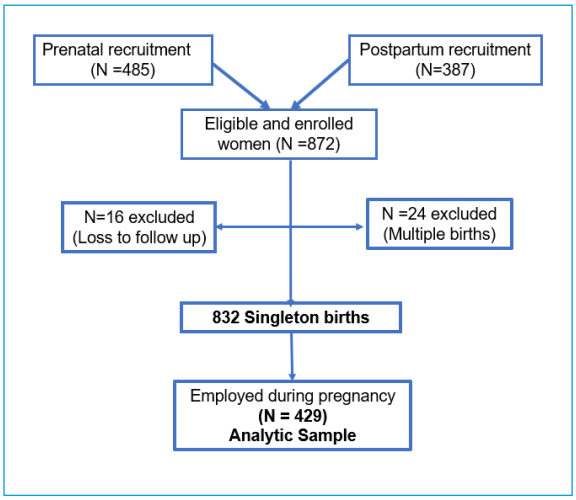
3.1 Target Population

The target population of this dissertation was Black women who had singleton births and were employed during pregnancy.

3.2 Design, Data Source, & Study Population

For this dissertation, we utilized data from a cohort study of Black women in Baltimore, MD. Women were eligible for enrollment in the cohort study if they: 1) self-identified as Black; 2) resided in Baltimore; 3) received prenatal care at one of the three Johns Hopkins Medical Institution (JHMI) prenatal clinics (prospective) or had their babies born at the JHMI hospital (retrospective).[92] Eight hundred seventy-two women were enrolled prenatally (N=485) or postpartum (before discharge) (N=387) during the three years of recruitment (2001-2004) with a response rate of 68 percent. Women enrolled prenatally were interviewed twice: 22-28 weeks gestation and postpartum hospitalization. Women whose enrollment was via postpartum (before discharge) were interviewed only at enrollment.[92] Postpartum recruitment allowed women with late or no prenatal care as well as those with sporadic care to be enrolled in the parent study. While postpartum recruitment may appear more susceptible to recall bias, previous studies show little evidence for bias in the recall of mother's pregnancy exposures.[47–52] Further, findings based on the Baltimore Study found little evidence of

Figure 2: Study flow chart



recall bias on key social environment measures and restriction to prenatal recruitment would have limited generalizability.[100] Postpartum enrollment of women was also demonstrated to reduce selection bias reported in studies that considered only prenatal care recruitment.[101–105] In-person interviews were conducted to obtain information on sociodemographic factors, psychosocial factors, and health behaviors. Prenatal and delivery medical records were abstracted to obtain data for gestation age, presence of chronic diseases, and any pregnancy complications. Trained research assistants with medical backgrounds conducted interviews and abstracted medical records.

For this dissertation, we restricted the analysis to women who had singleton births and were employed during pregnancy (429 women) (**Figure 2**). Several papers have been published using data from the Baltimore cohort.[92,100,106–108] Women with high lifetime experiences of racism had an elevated risk of PTB, and this effect was moderated by depressive symptoms and stress.[92] Further, group experiences of racism influenced early initiation of prenatal care.[100]

The Baltimore cohort was the ideal data source for this dissertation work because it includes measures that capture physical demands, psychological demands and job control (enabling categorization of job strain) as well as data on other dimensions of work exposures (e.g., hours worked) in an epidemiologic cohort of pregnant Black women. These measures are not commonly included in pregnant cohorts, although they have been utilized in non-pregnant individuals to assess the impact of employment on physical and psychological health.[68,69]

3.3 Study Measures

In this section, we include the key study variables that were the focus of our analysis: preterm birth (primary outcome), work exposures (hours worked, physical and psychological demands of work, and job strain), potential confounders, and moderators/ moderators. Details for the measurement and operationalization of these key variables are provided in the individual manuscripts in chapters 4 through 6.

3.3.1 Preterm birth: The primary outcome for this dissertation is preterm birth, defined as birth before 37 weeks of gestation are completed.[2] Measures of gestational age at delivery (including early ultrasound and last menstrual period) were abstracted from the medical record with a hierarchical algorithm to determine the most accurate gestational age at delivery.[106]

3.3.2 Work exposures: These include work hours, physical demands, psychological demands, and job strain.

Number of hours worked: Women self-reported the number of hours worked per week for their primary job in response to the question, “How many hours per week did you usually work?” This response reflected the usual hours worked in the first two trimesters for women (N=250) who were recruited prenatally (22-28 weeks gestation, late 2nd trimester). This response would have referred to all three trimesters for women (N=179) recruited during the postpartum hospitalization.

The other work exposures, physical demands, psychological demands, and job control were measured using Karasek’s demand and control questionnaire. Job strain is obtained from a combination of psychological demands and job control.

Physical demands were measured using relevant Karasek Job Demands and Control Scale (JDC) [34] items (e.g., lots of physical effort, moving or lifting heavy loads, rapid and continuous physical activity and working for long periods with body in physically awkward positions). Each item consists of a statement with the respondent asked to ascertain how much they agree. Responses range from 1 (strongly disagree) to 4 (strongly agree).

Psychological demands were measured using relevant JDC[34] items (e.g., hectic job, long periods of intense concentration, working very fast, working very hard). Each item consists of a statement, and the respondents are asked to ascertain how much they agree. Responses range from 1 (strongly disagree) to 4 (strongly agree).

Job strain: Measured using the women's responses to Karasek's demand control questionnaire.[109] Women's scores pertaining to psychological demands and job control (decision latitude) were formulated into subscale constructs – job demand and control. The median split and tertile cut-off levels on job demand and control constructs were used to arrive at the job strain categories.[110]

3.3.4 Covariates

We evaluated maternal characteristics (i.e., maternal education, age, marital/cohabiting, adequacy of resources, behavior, and parity) as potential confounders. Covariates were considered potential confounders if identified as confounders in the literature on workplace exposures and/or PTB.[38,76,111–114]

3.3.5 Moderation

We a *priori* conceptualized four factors as potential moderators of the workplace exposure-preterm birth associations: social support, depressive symptoms, stress, and lifetime experiences of racism. We considered these factors because they are important

for Black women's lives, there is variation within the analytic sample, and they are important predictors of PTB.

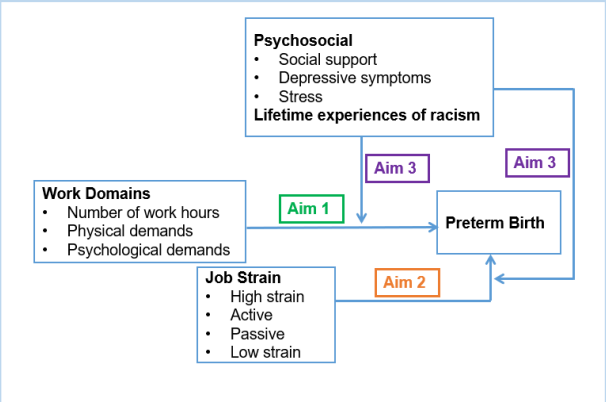
Depressive symptoms: Depressive symptoms were measured by the 20-item Center for Epidemiologic Studies Depression Scale (CES-D, Cronbach's α = 0.89).[115,116] Each item asked respondents to think about how often they experienced symptoms in the past week. Items were scored from 0 (rarely/never) to 3 (most of the time).

Stress: Stress was measured using the Prenatal Psychosocial Profile Hassles Scale[117,118] with 12 items. Respondents were asked to indicate to what extent things that occurred during pregnancy made them stressed. Examples include "worries about food, shelter, health care, and transportation,' 'money worries like paying bills,' 'problems related to family,' 'having to move,' either recently or in the future,' 'a recent loss of a loved one sexual,' 'emotional or physical abuse' etc. This scale utilizes a 4-point response for each item (1=no stress, 2=some, 3=moderate, or 4=severe). The scale has a Cronbach's α of 0.81.[119]

Social support was measured by a shortened Medical Outcomes Study Social Support Survey,[120], an 11-item scale (Cronbach's alpha= 0.90). We considered the dimensions of social and emotional support as global measures and were not specific to being within or outside the workplace. Respondents were asked how often specific kinds of support were available to them when they needed it. Examples include "someone you can count on to listen when you need to talk', 'someone to help with daily chores if you were sick,' 'someone to take you to the doctor if you needed it,' and 'someone to love and make you feel wanted'. Responses ranged from 1 (none of the time) to 4 (most of the time), with lower values indicative of less social support.

Racism life experiences: The Racism and Life Experiences Scale-Brief Version (RaLES-BRF) constructed by Harrell [121–123] was used to assess lifetime experiences with racism. This is a 9-item scale with Likert responses to assess lifetime exposure to racism in general (e.g., In general, how frequently do you hear about incidents of racial prejudice, discrimination, or racism from family, friends, co-workers, neighbors, etc.) The psychometric properties of the RaLES scales have been tested by various studies inclusive of diverse racial and ethnic populations and demonstrated a high reliability and strong construct validity.[124]

Figure 3: Conceptual Framework



3.4 Conceptual Framework

Figure 3 illustrates the overall conceptual model for the dissertation. Preterm delivery is the outcome and endpoint in this model. In addition to the workplace exposures (work hours, physical demands, psychological demands, and job strain), the following factors are considered in this framework: social support, depressive symptoms, stress, and lifetime experiences of racism. Our first hypothesis tests the association between work domains and preterm birth (Aim 1). Our second hypothesis tests the association between job strain and preterm birth (Aim 2). Additionally, we will evaluate whether social support, depressive symptoms, stress, and lifetime experiences of racism modify the association between workplace exposures and preterm delivery(Aim 3). Further, we considered maternal characteristics (education, age, marital/cohabiting, adequacy of resources, smoking, and parity) as potential confounders. Covariates were considered

potential confounders if identified as confounders in the literature on workplace exposures and/or PTB.[38,76,111–114]

3.5 Analytic Strategy

Following our conceptual framework (**Figure 3**), we tested the proposed association between work exposures and preterm birth. Further details of the methods are provided in the individual manuscripts in chapters 4 through 6. We summarized the descriptive characteristics of the study population using frequencies and percentages. Bivariate and multivariable analyses using log-binomial regression models will be conducted to estimate prevalence ratios (PR) and their corresponding 95% confidence intervals (CI).[125,126] Log-binomial models were used to approximate PRs instead of logistic regression since the PTB rate in the cohort (16.6%) does not meet the rare disease assumption (outcome prevalence <10%).[127] In multivariable analyses, we applied a forward stepwise approach, beginning with crude (unadjusted) models that include individual work exposures. These models were adjusted sequentially for sociodemographic and behavioral factors, parity, and adequacy of family resources. To determine which variables to include in the multivariable models, a p-value less than 0.25[128] for the unadjusted associations was suggestive of potential significance. We hypothesized *a priori* that the psychosocial factors and lifetime experiences of racism could modify the effects of work on PTB. We will explore moderation on a multiplicative scale by adding an interaction term between the work exposure and the potential moderator to the adjusted regression models. We will compare the likelihood ratios (LRs) to determine whether the model with interactions provides a better fit to the data than the model without them. We will determine the significance of the interaction terms

using the Likelihood Ratio (LR) chi-square test, and if the associated p-value is less than 0.10, then estimate the stratum-specific estimates of association. All analyses will be conducted using SAS software, version 9.4 (SAS Institute, Cary, NC).

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CHAPTER 4: THE IMPACT OF PHYSICAL DEMANDS AND WORK HOURS ON THE RISK OF PRETERM BIRTH AMONG BLACK WOMEN (MANUSCRIPT 1)

Abstract

Background: Preterm birth (PTB) contributes substantially to neonatal mortality, morbidity, and long-term neurological disabilities. How the work environment relates to the risk of PTB preterm birth is a relatively less studied area, particularly among Black women who experience the highest risk for PTB in the United States. Our study objective was to determine the prevalence of work characteristics, examine how work hours and physical demands in the prenatal period relate to the risk of PTB among Black mothers, and identify psychosocial factors that may act as moderators of any associations.

Methods: Using data from a hybrid prospective and retrospective cohort study of Black women residing in Baltimore, we conducted a within-group analysis restricted to the 429 women employed during pregnancy. Work hours were self-reported as the number of hours worked per week. The Job Demands and Control Scale (JDC) was used to assess the prenatal work environment pertaining to physical demands. Log binomial regression analyses were used to determine the role of work hours and physical demands on the risk of PTB (<37 weeks completed gestation) and to adjust for the potential covariates. Moderation by psychosocial factors (e.g., social support, depression, stress) and racism was assessed on a multiplicative scale, with interactions considered significant at a p-value was less than 0.10. Results are presented as adjusted prevalence ratios (aPR) and 95% Confidence Intervals (CI).

Results: Of the 429 Black women employed during pregnancy, 71(16.6%) had a PTB. Women whose jobs required moving or lifting heavy loads had a modest non-significant

association with PTB (aPR = 1.33; 95% CI: 0.88, 2.00). Women who worked long periods with their bodies in physically awkward positions had non-significant lower PTB rates (aPR = 0.67; 95%CI: 0.43,1.07). Similarly, there was a positive, non-significant association between prolonged work hours (> 40 hours/week) and PTB (aPR = 1.56; 95% CI: 0.75, 3.24). Timing of recruitment moderated the prolonged work hours-PTB association, such that women enrolled postpartum had elevated PTB rates when working longer hours (aPR= 2.65; 95%CI: 1.00,7.01). Social support significantly moderated the association between working with awkward body position and PTB (*awkward body position*social support p= 0.03*), such that working with the body in awkward positions versus not was associated with lower PTB rates among women with high social support (aPR: 0.45; 95% CI: 0.23, 0.88). Further, social support moderated the high physical demands score (above or at the median)-PTB association (*physical demands*social support p = 0.09*), such that high physically demanding work was associated with high PTB rates among women with low social support (aPR:1.90; 95% CI: 0.94,3.85).

Conclusion: Our results suggest that physically demanding activities and working for prolonged hours may increase PTB rates in Black women. In this study, work factors (number of work hours and physical demands) were not significantly associated with PTB among Black women. However, interactions between the physical demands of work and social support suggest that impacts are intertwined. Intervention efforts could focus on these factors. Findings highlight the need to develop social and economic policies focused on accommodation reforms that will improve the livelihood of Black pregnant women in the workforce.

4.1 Introduction

Preterm birth (PTB) is a major obstetric problem contributing to most neonatal mortality, morbidity, and long-term neurological disabilities.[1] Annually, it affects nearly 15 million babies born globally[2] and 1 of every 10 infants born in the United States (U.S.).[2,3] Black women are 1.6 times more likely to experience PTB compared with white women.[3,4] PTB is the leading cause of infant mortality among Black infants.[2] Surviving infants are at increased risk of having cerebral palsy, developmental delays, vision, hearing problems, and cardiovascular disease during adulthood.[3,5–7] While maternal characteristics like education, socioeconomic status, and smoking have been identified to be associated with PTB, these factors do not explain the disproportionate effect of PTB on Black women, supporting the need to explore other factors.

While many potential risk factors for PTB in the prenatal and even pre-conceptional environment have been extensively studied, workplace exposures and experiences during pregnancy have rarely been studied. Such work has been even less frequent in large epidemiologic or clinical studies on PTB among Black women. While U.S. women have always contributed to the workforce,[8–10] the proportion of women employed has risen, and most continue working throughout pregnancy.[11–13] Women continue working during pregnancy for various reasons, including financial stability, personal fulfillment, health insurance, and paid leave, which they may have to forfeit if they opt out of employment. Yet employment during pregnancy can have both physical and psychological dimensions that may increase some workers' PTB risk. While leisure time physical activity appears to reduce the risk of PTB,[14] physical activity in a work environment may not necessarily be beneficial. Work activity may be more physically

demanding and endured for 8 hours or longer for women with extended shifts. Work-related physically demanding activities, like heavy lifting, demanding body posture and prolonged standing or walking, have been associated with increased risk of PTB.[15–22]

Existing findings on the relationship between the physical demands of work and PTB are inconsistent.[15–17,22–30] In most studies, recruitment occurred during prenatal care with exposure assessment based only on the early part of the pregnancy. Some studies evaluated multiple work exposures, while others focused on a single exposure. Measures for work exposures were variable, i.e., using single items rather than scales to assess workplace conditions or experiences.[16,18,22,23] To date, some studies showed an increased risk of PTB with selected work exposures (heavy lifting[15,30]; prolonged work hours[25]; demanding body posture[16,23]; occupational physical activity[22]). Others detected no significant association between work exposures (physically demanding work[30]; physical workload[17]; prolonged work hours (>=40 hours/week)[16,23,24] and PTB. Two studies reported that working during pregnancy offered a protective effect on the risk of PTB.[24,28]

There are important gaps in prior work that we address here. First, only three studies include Black women,[22,28,31] the group with the highest risk for PTB in the U.S.,[3] in studies of workplace exposures and experiences during pregnancy. To address this gap, we analyzed data from a large Black-only cohort that included exposures unique to Black women, chiefly racism. Second, psychosocial factors (e.g., stress, depressive symptoms, social support) and lifetime experiences of racism have been implicated in risk of PTB,[32,33] and found to be important moderators in studies of PTB within cohorts of Black women[34–36]. However, these factors, which could amplify or buffer the impact of

workplace exposures, have not been examined in workplace and PTB studies. Prior reports that investigated work factors and PTB examined moderation by race, but not by racism or psychosocial factors,[31] or simply controlled for maternal race as a covariate.[28] For mothers dealing with psychosocial factors and racism, such factors could affect their resilience and add to the strain a mother experiences in the work environment.

Our study objective was to 1) describe the prevalence of work characteristics during pregnancy among our cohort of Black women; 2) evaluate the associations between work factors (i.e., prolonged work hours, physical demands: construct and individual measures) and PTB; and 3) determine whether levels of depressive symptoms, social support, perceived stress, and lifetime experiences of racism modify the association between work factors and PTB.

4.2 Methods

4.2.1 Design, Data, and Study Population

For our analysis, we utilized the Baltimore study[35] a hybrid cohort (prenatal and postpartum recruitment) of pregnant Black women in Baltimore, Maryland, U.S. Women were eligible for enrollment in the cohort study if they: 1) self-identified as Black; 2) resided in Baltimore; and 3) received prenatal care at one of three Johns Hopkins Medical Institution (JHMI) prenatal clinics (prospective) or delivered at the JHMI hospital (retrospective).[35] A total of 872 women were enrolled prenatally or postpartum (before discharge) during the three years of recruitment (2001-2004), with a response rate of 68%. Women enrolled prenatally were interviewed twice: 22-28 weeks gestation and postpartum hospitalization. Women whose enrollment was via postpartum were interviewed only at enrollment.[35] In-person interviews were conducted to obtain

information on sociodemographic factors, psychosocial factors, and health behaviors. Prenatal and delivery medical records were abstracted by trained research assistants with medical backgrounds to obtain data for gestation age, presence of chronic diseases, and any pregnancy complications. After excluding multiple births (n = 24) and participants lost to follow-up (n = 16), 832 participants had medical record data on the pregnancy and birth. For this study, we utilized data from the 429 women employed during pregnancy. The proportion of missing data on any single variable studied was small (<2%), so imputation of missing data was deemed unnecessary.[37]

Ethical approval

The Baltimore study was evaluated and authorized by institutional review boards at the relevant institutions.[38]

4.2.2 Measures

4.2.2.1 Outcome: Preterm Birth (PTB)

The current study's primary outcome was PTB, defined as birth before 37 completed weeks of gestation.[39] Measures of gestational age at delivery, including early ultrasound and last menstrual period (LMP), were abstracted from the medical record with a hierarchical algorithm to determine the most accurate gestational age at delivery.[40] The algorithm prioritized early ultrasound followed by the mother's reported LMP date, followed by late ultrasound, and then the clinician estimates if nothing else was available. Generally, prospective studies rarely rely on late ultrasound or clinician estimates because women get into care early, but in our study, because of the postpartum recruitment of women with no or late prenatal care, reliance on late ultrasound (0.9%) or clinician estimates (1.2%) was necessary.

4.2.2.3 Exposures: Work factors

Number of hours worked: Women self-reported the number of hours worked per week for their primary job in response to the question, “How many hours per week did you usually work?” This response reflected the usual hours worked in the first two trimesters for women (N=250) who recruited prenatally (22-28 weeks gestation, late 2nd trimester). For women (N=179) recruited during the postpartum hospitalization, this response would have referred to all three trimesters. If women reduced work as pregnancy progressed, this could have resulted in a lower number of hours worked among postpartum recruited participants. However, we found the opposite with postpartum participants working significantly more hours per week (average difference +2.6 hours; 95% CI: 0.73,4.42; p=0.007). Recruitment timing was therefore examined as a potential confounder.

Physical demands: Measured using relevant Karasek Job Demands and Control Scale (JDC) [41] items (lots of physical effort, moving or lifting heavy loads, rapid and continuous physical activity, and working for long periods with the body in physically awkward positions). Each item consists of a statement, and the respondent is asked how much they agree. Responses range from 1 (strongly disagree) to 4 (strongly agree). Items were summed to create a single, continuous variable (physical demands composite), with lower values correlating to lower demands, and quartiles and median splits were used to construct a categorical variable for further analysis. Finally, individual items were dichotomized into strongly agree/agree and strongly disagree/disagree to model as exposures (physical demands measures).

4.2.2.4 Covariates

We evaluated maternal characteristics (maternal education, age, marital/cohabiting,

adequacy of resources, behavior and parity) as potential covariates. Covariates were considered potential confounders if identified as confounders in the literature on workplace exposures and/or PTB.[42–47] We didn't consider chronic diseases and pregnancy complications as covariates as these conditions were rare in our study sample.

In-person interviews were used to obtain information on age and marital status. Age was measured as a continuous variable, and we created 4 age groups (≤19; 20-24, 25-29, 30+) for the analysis, and we used 25-29 years as the reference. Women were asked if they were married, cohabiting, or single. We combined the married and cohabiting groups for our study and used the single group as our reference. Education was measured as a continuous variable indicating the highest grade/year of school completed. For our study, we created 3 groups: Less than high school, high school diploma / GED and beyond high school and used less than high school as our reference. The Family Resources Scale[48] (FRS), a 25-item instrument was used to assess the adequacy of time and money for essential (e.g., rent, clothing, food, etc.) and non-essential (e.g., time to socialize, money to buy things for yourself, money to save, etc.) resources[48,49]. Women were asked how often they had specific resources. Examples include "enough money to buy food for two meals a day while you were pregnant" and "enough money to pay your monthly bills." Item responses were measured by a Likert scale ranging from 1 (almost always) to 5 (almost never), so lower values correlated with greater family resources. Items were summed and quartiles were used to construct a categorical variable for further analysis. Smoking was measured by a brief set of standard questions to determine lifetime exposure to smoking and

exposure to smoking by trimester (yes/no, amount) and cessation. Parity (≥1 previous live births vs. no previous live births) was obtained using the medical history abstraction instrument and confirmed with the maternal interview. Timing of recruitment was also considered as a potential confounder. Women recruited prenatally would have responded to the questions regarding their work activities in the first two trimesters of pregnancy, with a possible focus on the second trimester. Those recruited postpartum would be responding about the entire pregnancy, with a possible focus on the third trimester. Those recruited postpartum were more likely to have no, late, or less prenatal care and were at higher risk of PTB.[38]

4.2.2.5 Moderators

We conceptualized *a priori* psychosocial factors (depressive symptoms, stress, social support) and lifetime experiences of racism as potential moderators of the workplace exposure-PTB associations. We considered these factors because they are important for Black women's lives, and there is variation within the cohort. We also explored the timing of study recruitment as a moderator.

Depressive symptoms were measured by the 20-item Center for Epidemiologic Studies Depression Scale (CES-D)[50,51] and had a Cronbach's α of 0.89.[35] Each item asked respondents to think about how often they experienced symptoms in the past week. Items were scored from 0 (rarely/never) to 3 (most of the time), summed, and a cut point of ≥16 was used to create a dichotomous variable. The value of 16 has been frequently used to indicate a likely diagnosis of depression[38] and found to be associated with PTB.[52,53]

Stress was measured using the 12-item Prenatal Psychosocial Profile Hassles Scale, [54,55] this scale utilizes a 4-point response for each item (1=no stress, 2=some,

3=moderate, or 4=severe). The scale has a Cronbach's α of 0.81.[48] Responses for each item range from 1 (no stress) to 4 (severe). Items were summed to create a continuous variable with lower values correlating to no/less stress. Quartiles were used to construct a 4-level categorical variable for analysis. Items were summed (lower values correlating to no/less stress), and quartiles were used to construct a categorical variable for further analysis. Scores above the top quartile have been associated with PTB in this cohort.[34,38]

Social support was measured by the social support scale (Cronbach's alpha = 0.94[48]), an 11-item scale created from the Medical Outcomes Study Social Support Survey.[56] We considered the dimensions of social and emotional support as global measures and were not specific to being within or outside the workplace. Respondents were asked how often specific kinds of support were available to them when they needed it. Examples include "someone you can count on to listen when you need to talk', 'someone to help with daily chores if you were sick,' 'someone to take you to the doctor if you needed it,' and 'someone to love and make you feel wanted'. Responses ranged from 1 (none of the time) to 4 (most of the time) and were summed (lower values correlating to no/low social support), and quartiles were used to construct a categorical variable for analysis.

Racism life experiences: The Racism and Life Experiences Scale-Brief Version (RaLES-BRF) constructed by Harrell [57–59] was used to assess lifetime experiences with racism. This is a 9-item scale with Likert responses to assess lifetime exposure to racism in general (e.g., In general, how frequently do you hear about incidents of racial prejudice, discrimination, or racism from family, friends, co-workers, neighbors, etc.).

The psychometric properties of the RaLES scales have been tested by various studies inclusive of diverse racial and ethnic populations and demonstrated a high reliability and strong construct validity.[60] Items were summed and then categorized by quartiles and median values for further analysis. Scores above the median (more racism) were reported by Misra et al. only to be associated with the risk of PTB in the context of high stress and/or high depressive symptoms.[35]

4.2.3 Statistical Analysis

Frequencies and percentages were used to summarize the descriptive characteristics of the study population. We conducted bivariate and multivariable analyses using log-binomial regression models to estimate prevalence ratios (PR) and their corresponding 95% confidence intervals (CI).[61,62] Log-binomial models were used to approximate PRs instead of logistic regression since the PTB rate in the cohort (16.6%) does not meet the rare disease assumption (outcome prevalence <10%).[63] In multivariable analyses, we applied a forward stepwise approach, beginning with crude (unadjusted) models that included work factors, then sequentially adjusted for social and behavioral factors, parity, and adequacy of family resources. To determine which variables to include in the multivariable models, a p-value of <0.25[64] for the unadjusted associations was considered suggestive of potential significance. We hypothesized *a priori* that the psychosocial factors and lifetime experiences of racism could modify the effects of work on PTB. We explored moderation on a multiplicative scale by adding an interaction term between the exposure and the potential moderator to the adjusted regression models. We compared the likelihood ratios (LRs) to determine whether the model with interactions provided a better fit to the data than the model without them. We determined the significance of the interaction terms using the Likelihood Ratio (LR) chi-

square test and if the associated p-value was less than 0.10. Additionally, we stratified our adjusted regression model by the timing of recruitment. All analyses were conducted using SAS software, version 9.4 (SAS Institute, Cary, NC).

4.3 Results

The mean age for the participants was 24.0 years. Of the 429 participants,16.6% had PTB, 41% experienced a high level of depressive symptoms, 50% were married or cohabiting, and 66% of the women had attained a high school diploma/GED or training beyond high school (Table 1). Overall, 38.5% of the participants worked less than 40 hours a week, and 61.5% worked 40 or more hours per week. Approximately 50% had physically demanding jobs based on the summary measures of physical demands (Table 2).

Bivariate significant associations of non-work factors with PTB included (Table 1): low social support; smoking during the second trimester; unmet needs (less resources) regarding time and money; high levels of depressive symptoms and high stress. Work factors (prolonged work hours, physical demands composite and the individual physical demands measures) were not significantly associated with PTB in bivariate analyses (Table 3).

Consistent with the crude models, neither working for prolonged hours, physical demands composite nor any specific physical demands measures were significantly associated with PTB, regardless of covariate adjustment. Women who worked more than 40 hours per week had a higher but non-significant PTB risk compared to women who worked 40 or fewer hours per week (aPR = 1.56; 95% CI: 0.75, 3.24). Analyses focused on the physical demands composite quartiles and median distributions did not

identify any significant associations with PTB, and the estimates were close to the null. For individual physical demands measures, women whose jobs required heavy lifting had a modest, yet non-significant association with PTB (aPR = 1.33; 95% CI: 0.88, 2.00). Women who worked long periods with their bodies in physically awkward positions had lower, yet non-significant, PTB rates (aPR = 0.67; 95% CI: 0.43,1.07). Similarly, women who worked long periods with their heads/arms in physically awkward positions had lower PTB rates, but the confidence interval included the null value of 1 (aPR = 0.83; 95%CI: 0.51,1.33) (Table 3).

Sensitivity analysis

We conducted a sensitivity analysis that focused on only women who continued working during the second trimester. We did not observe any significant differences in PTB risk for individual measures or physical demands composite from the estimates obtained when we considered all women regardless of when they stopped working.

Moderation

Figure 1 and supplementary tables (*S1-S4*) show the results of moderation analyses. Social support significantly moderated the association between working with awkward body position and PTB in a protective way (*awkward body position*social support p= 0.03*). Among women with higher social support (top quartile), working long periods with the body in physically awkward positions was associated with low PTB rates (aPR: 0.45; 95% CI: 0.23, 0.88). We also observed evidence of moderation for physical demands score above or at the median with social support (*physical demands*social support p = 0.09*), such that working high physically demanding work

was associated with high PTB rates among women with low social support (aPR:1.90; 95% CI: 0.94,3.85) (Figure 1 and Table *S1*).

Neither depression, stress, or racism moderated the relationship between work factors and PTB *(supplementary tables S2- S4).*

We also explored the timing of recruitment, and thus data collection, as a potential moderator. Timing of recruitment may have led to heterogeneity in what the work exposures reflect (second vs. third trimester or 1st & 2nd vs. all 3 trimesters). We found no evidence of moderation by recruitment for any of the physical demands individual measures or the composite. However, women enrolled postpartum had elevated PTB rates when working longer hours (aPR= 2.65; 95%CI: 1.00,7.01) but working longer hours mattered little for those enrolled prenatally *(*Table 4*).*

4.4 Discussion

How work impacts the risk of PTB has not been extensively studied among Black women in the U.S., the group that is disproportionately affected by PTB.[3] A recent meta-analysis[65] identified twenty-five papers on work factors (physical workload, lifting, and working hours) and PTB, and just six focused on U.S. populations. Most of these studies used data collected prior to 2000 and studied work exposures in the 1980s. Even fewer studies[22,28,66] considered how the physical demands of work impact the risk of PTB among Black women, who are at the highest risk for PTB.[3] In our study, we aimed to determine the prevalence of work characteristics, evaluate the effect of work factors (prolonged work hours, physical demands: composite and individual measures) on the risk of PTB, and determine whether these associations were moderated by psychosocial factors (depressive symptoms, stress, social support) and lifetime

experiences of racism among Black women. In the following paragraphs, we provide an overview and discussion of our study results for the prevalence, PTB associations with prolonged hours, physical demands composite and physical demand measures, and findings of the moderation analysis.

4.4.1 Prevalence of PTB and work factors

Our study estimated PTB in more than 16% of working women, indicating a high burden of PTB for this minoritized population. Our sample also had a high prevalence of demanding working environments, with 50% scored as having physically demanding jobs, and 62% reported working 40 or more hours per week. No published work has reported on the prevalence of physically demanding jobs among Black women. In the prior publications that included data from Black women, Pompeii et al.[28] reported on the prevalence of work factors (heavy lifting and hours worked per week) and prevalence ratio associations, while Bell et al.[66] reported only the prevalence of work hours and odds ratio associations for the exposure to physical demands. Pompeii et al.[28] reported an overall prevalence of 59% for women working over 35 hours per week and 40% for women whose work involved lifting heavy loads. Bell et al.[66] reported an overall prevalence of 69% for women working for 40 or more hours per week. To date, there's limited evidence, including or excluding Black women, regarding the prevalence of physically demanding jobs during pregnancy. However, based on the broader literature on race/ethnicity and working conditions for women outside of pregnancy, physically demanding jobs are typical.[67–72]

4.4.2 Prolonged work hours (more than 40 hours per week)

The number of work hours has been examined,[16,23–25,73] but most of those

studies did not include Black women. Our study found a positive, nonsignificant association between working for prolonged hours and PTB. Our findings are consistent with other studies that have reported positive associations, albeit without statistical significance.[46,74] However, our results contradict the findings from Bonzini et al,[16] in a longitudinal study that reported no association and others that indicated a significant positive association.[25,75] Cai et al.,[76] in a recent metanalysis, reported a significantly increased PTB risk associated with more than 40 hours per week compared to 40 hours or less per week (OR=1.21; 95% CI: 1.11,1.33).[76] In addition, in a linear dose-response meta-regression analysis, Cai et al. reported a 10% increased odds of PTB for women who worked 55.5 hours per week compared to those who worked 40 hours per week.[76] Our study had a smaller sample size compared to the studies evaluated by Cai et al.,[76] and this could have prevented our study from identifying real effects. Another limitation of the present and prior studies is the focus on the hours of work in formal paid employment. Informal work may impose a strain that is not well captured in studies of work and pregnancy.

4.4.3 Physical demands composite

In our study, evaluation of the role of physical demands composite (summation of the 5 items) quartiles and median distributions on PTB identified no significant associations. Our findings are similar to those of Von Ehrenstein et al.,[77] in a US study and others from Portugal,[47] Ireland,[46] and the Netherlands[17] who reported no significant associations between physical demands and PTB. Our findings contradict other studies that have reported significant PTB associations with high physical demands.[66,73,78–81] Only Bell et al.[66] of these studies included data for Black women. Findings from this

study show that Black women experienced a higher PTB risk (OR=1.48; 95% CI: 1.20,1.83) compared to White women (OR=1.01; 95% CI: 0.86,1.18). The authors alluded to the possibility of Black women being assigned to high physically demanding work activities coupled with stress, hence increasing their vulnerability to PTB risk. However, this study had a larger sample size than ours (N= 2508 vs. N=429); hence, it had more power to detect the direct effect of physical work demands on PTB. Further, Bell et al.[66] obtained the physical demands measures from job titles, which they indicated may have limited recall bias and exposure misclassification.[82] However, using job titles may not consider individual variability and may miss out on differences by duration of exposure.[31] Our study utilized data directly obtained from women using the JDC questionnaire. Additionally, four of the studies that reported significant associations were case control,[78–81] hence subject to recall bias.

4.4.4 Physical demands measures: Heavy lifting

Further analysis of the individual physical demands measures showed a modest, albeit non-significant, positive association between heavy lifting and PTB. Our findings are consistent with a Denmark cohort study that reported a non-significant positive association with PTB risk for women who lifted heavy loads (OR=1.40; 95% CI: 0.88, 2.23).[30] Lawson et al. also reported similar results in a cohort study of nurses that examined different occupational exposures, including heavy lifting (OR=1.20; 95% CI: 0.80,2.00).[83] Further, Bonzini et al.[16] and Saurel-Cubizolles et al.[25] reported no significant association with occupational lifting. Only one study[28] that included data for Black women, but controlled for race rather than investigating the role of racism, considered occupational lifting in evaluating work conditions and PTB risk, and the findings were similar to our study (OR=1.30; 95% CI: 0.90,1.80). On the other hand,

other studies that explored occupational heavy lifting reported a significant positive association with PTB risk [15,73,78,80] and even indicated a dose-response relation between total daily load and PTB risk.[15] In the most recent meta-analysis, Cai and colleagues reported a higher PTB risk associated with lifting loads ≥100kg per day (OR=1.31; 95% CI: 1.11,1.56) and heavy physical workload (OR=1.23; 95% CI:1.07,1.41).[18]

4.4.5 Physical demands measures: Working with physically awkward body positions

Our results indicated a modest protective effect for women who worked for long periods with bodies in physically awkward positions and a weak non-significant association for those who worked for long periods with their heads/arms in physically awkward positions. Most of the women who reported working for long periods with the body in physically awkward body positions worked as nursing assistants, hairdressers, housekeepers, and in the food service workplace. Our findings contrast with Croteau et al., in a Canadian case-control study, who reported a PTB association with demanding body posture for ≥3 hours per day (OR=1.40; 95% CI: 1.20,1.70).[23] Similarly, Bonzini and colleagues reported a threefold increase in PTB for U.K. women whose activities involved bending in the last trimester.[16] Further, findings from a U.S. National Birth Defects Prevention Study indicated an increased PTB risk for occupational activities that involved trunk bending for more than one hour per day.[22]

4.4.6 Physical demands measures: Physical effort and rapid physical work activity

Our study did not find an association between specific individual physical demand measures (physical effort and rapid and continuous physical activity) examined as separate exposures with PTB. Lack of association may be due to the possibility of healthier women[84] being involved in such work activities or women who had more control over their schedule and better coping mechanisms for stress that may arise from

such activities. Further, the small sample size could have limited our ability to detect the direct effect of these measures on PTB.

4.4.7 Physical demands summary

The inconsistent findings between past studies and our work may be due to heterogeneity in exposure assessment. Some studies evaluated multiple work exposures,[16,22,23] while others focused on a single exposure.[15,26,27,29,85] Different measures of exposures were also used i.e., single items rather than scales to assess workplace conditions or experiences.[16,18,22,23] Our study is the only one that has utilized the Karasek job demand control questionnaire, a comprehensive instrument that uses multiple items to assess the effect of physical work conditions on PTB risk in a cohort of Black women.[41]

4.4.8 Moderation

In contrast to previous publications, and unique to our study, we explored the potential for moderation by psychosocial factors. We found that social support moderated the relationship between PTB and working with physically awkward body positions in a protective way, as women whose jobs involved physically awkward body positions with high social support were less likely to experience PTB than those with low social support. Further, social support moderated the relationship between high physical demand score (above or at the median) and PTB, such that highly physically demanding work was associated with PTB among women with low social support. Our findings suggest that high social support may mitigate the effects of physically demanding work on PTB, and low or lack of social support may magnify the effect of physical demands on PTB. It's possible that social support through interactions with

social networks may alleviate the stress caused by physically demanding work.[86] Additionally, social support may provide women with coping resources to deal with other competing interests outside work during pregnancy (e.g., help with house chores, errands, child care, and transportation for prenatal care visits).[86,87] Prior studies[48,88–94] have examined the direct effect of social support on PTB and reported inconsistent findings. Some studies[89,90] have reported a significantly increased PTB risk with low social support, and others[93] indicated that high social support decreased stress levels and, combined with other factors, reduced PTB risk. On the contrary, other studies reported no significant relationship between social support and PTB.[48,88,91,94] However, these previous studies did not evaluate the moderating effect of social support on the association between work factors and PTB. Future studies should consider how psychosocial factors may be interrelated with work exposures.

In our study the timing of recruitment moderated the association between hours worked and PTB association, such that working for prolonged hours (more than 40 hours per week) was associated with high PTB rates among women who were enrolled during their postpartum hospitalization. It is possible that the postpartum recruitment group is more vulnerable to the effects of prolonged work, and therefore it could harm them more. The unique feature of our study is that it includes postpartum recruited women, who are usually missed by studies that focus only on prenatal recruitment. Women who were recruited postpartum may not have attended regular prenatal visits due to not being able to get leave from work. Therefore, it is possible that the postpartum group has multiple known and unknown vulnerabilities to PTB. Further, our study is the first one to evaluate the moderating role of the timing of recruitment on the

PTB-work exposure associations. Prior studies have considered the timing of exposure when examining the effect of workplace exposures on PTB. Some studies have examined exposures during the first trimester,[25,95] others the second trimester,[96,97] others considered both the second and third trimester,[98,99] while others have not stated the timing of exposure.[75,100–102] Only a small number of studies have considered the effect of workplace exposures during the third trimester, a crucial pregnancy window that may trigger the onset of delivery.[16,31,103] Brett et al.[31] reported no significant association with PTB when they considered exposure to high-strain jobs during the third trimester. Similarly, Bonzini et al.[16] in a UK longitudinal study, reported no association between prolonged work hours and very early PTB (34 weeks). Further, Pompeii et al.[103] reported no significant association between PTB and work exposures (standing for 30 hours per week or heavy lifting) during the third trimester. The authors[103] alluded to the possibility of the healthy worker effect,[84] where healthier women who could complete physically demanding work activities were recruited into such jobs or did not need to withdraw from such work late in their pregnancy.

There was no moderation seen for the physical demands-PTB association by racism. Our study had 86% of the women aged ≤ 29 years; it is possible that this may have been a limitation for our study to capture the effects of lifetime experiences of racism, as such experiences may greatly impact older women who have been exposed for a longer period.[38] Further, racism experiences may be important in the workplace context for PTB, but our specific measure may not have captured them. In our future studies, we will consider evaluating racism experiences specific to the workplace to capture the effect of racism.

Strengths

We utilized data from a large cohort of Black women who are at elevated risk for PTB. Investigating the effects of workplace exposures on PTB provides novel empirical evidence on the role of multi-dimensional work exposures on PTB among Black mothers. We evaluated a rich set of domains of working conditions. While the case-control study of Brett, Strogatz, and Savitz (1997) also included a job strain measure, their study focused on psychosocial rather than physical working conditions and did not explore moderation beyond stratifying on race. Therefore, our study is the only data source that uses the Karasek Job-Demand Control scale and measures of PTB, with the necessary contextual data (e.g., social and psychosocial factors) to explore moderation. Past studies have rarely evaluated the role of psychosocial factors when assessing the association between work and PTB; the findings from this study suggest that social support is moderator.

The strengths of the study design and data collection of the parent study are also important to note. Postpartum recruitment allowed women with late or no prenatal care, and those with sporadic care to be enrolled in the parent study, increasing the generalizability of study results[104] and reducing potential selection biases.[105–109] While postpartum recruitment may appear more susceptible to recall bias, previous studies show little evidence for bias in the recall of mothers' pregnancy exposures.[110–115] The parent study also included extensive data on potential confounders as it focused on a wide range of predictors of PTB, including health behaviors, often absent in studies of working conditions in pregnancy. Similar to our study, the 3 publications that included data for Black women obtained information on health behaviors using interviews.[22,28,31]

Studies that rely on birth certificates or medical record data alone do not include the nuanced data collected in our interviews.[30] Finally, only Black women residing in Baltimore City were recruited, resulting in the ability to study a group socially at high risk for PTB and rarely reported on in studies of working conditions and birth outcomes.

Limitations

Using cross-sectional data for many analyses limits the ability to infer causality between work exposures and PTB risk. In addition, our cohort was recruited in the early 2000s, and there have been secular changes. While that may affect the prevalence of workplace exposures, the PTB rate has improved very little for Black women. Contextual factors like stress and social support may also have changed. However, a strength of our study was the exploration of contextual factors through moderation analyses. We have little reason to expect that the associations would have changed over time, but it is a limitation. We hope to conduct similar work in the future to address changes in the workplace. Further, we did not explore the role of the type of occupation that women had on PTB risk. We hope to explore this effect to elucidate the relationships in our future studies.

Significance

To our knowledge, this is the first study to investigate the associations between physical demands of work using comprehensive measurement tools and PTB in Black women. The recent passage of the U.S. 2024 Pregnant Fair Workers Act, requiring employers to accommodate women in pregnancy, provides an opportunity for data-driven protection.[116] Understanding how work may increase or decrease the risk of PTB among Black mothers provides additional insight to mitigate modifiable determinants

that drive racial disparities.. However, it is critical to note that workforce inequities result from social forces that may determine where women work and the jobs they are involved in and, therefore, workplace exposures that may increase their risk to PTB. Developing research strategies that reduce PTB in high-risk populations is vital and contributes toward decreasing national PTB rates. This work highlights the need for social and economic policies to improve the livelihood of pregnant women in the workforce. Some accommodations that may be helpful for pregnant women may include reducing physical strenuous activities within the job role (heavy lifting, awkward body positioning) and flexible working hours.

4.5 Conclusion

Our results suggest that physically demanding work activities involving heavy lifting and working for prolonged hours may increase PTB rates in Black women. Further, the interaction between the physical demands of work (working long periods with the body in physically awkward positions) and social support suggest that impacts are intertwined. Intervention efforts should focus on work exposures and moderating factors. These findings highlight the need to develop social and economic policies focused on accommodation reforms to improve the livelihood of Black pregnant women in the workforce.

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4.6 Tables and Figures

Table 1: Distribution of maternal characteristics: univariate and bivariate distributions with preterm birth, Baltimore Study (N=429), 2001-2004

	Total Sample N(%)	Preterm N(%)	No Preterm N(%)	Crude PR (95% CI)
Maternal factors				
Maternal age (Years)				
≤19	79(18.4)	16(20.3)	63(79.8)	1.54(0.79,3.01)
20-24	190(44.3)	29(15.3)	161(84.7)	1.16(0.63,2.13)
25-29	99(23.1)	13(13.1)	86(86.9)	Ref
30+	61(14.2)	13(21.3)	48(78.7)	1.62(0.81,3.27)
Maternal Education				
Less than high school	144(33.6)	24(16.7)	120(83.3)	Ref
High school diploma /GED	225(52.4)	37(16.4)	188(83.6)	0.99(0.62,1.58)
Beyond high school	60(14.0)	10(16.7)	50(83.3)	1.00(0.51,1.96)
Married/Cohabiting				
Yes	213(49.7)	37(17.4)	176(82.6)	1.10(0.72,1.69)
No	216(50.3)	34(15.7)	182(84.3)	Ref
Smoking during the second trimester				
Yes	73(17.1)	18(24.7)	55(75.3)	**1.68(1.05,2.69)**
No	354(82.9)	52(14.7)	302(85.3)	Ref
Parity				
≥ 1 previous live births	285(66.4)	47(16.5)	238(83.5)	0.99(0.63,1.55)
No previous live births	144(33.6)	24(16.7)	120(83.3)	Ref
Family resources scale: time subscale				
Quartile 1 (more)(7-9)	124(29.2)	15(12.1)	109(87.9)	Ref
Quartile 2 (10-12)	102(24.0)	11(10.8)	91(89.2)	0.89(0.43,1.85)
Quartile 3 (13-17)	110(25.9)	20(18.2)	90(81.8)	1.50(0.81,2.79)
Quartile 4 (less)(18-35)	89(20.9)	23(25.8)	66(74.2)	**2.14(1.18,3.86)**
Top quartile (≥18)	89(20.9)	23(25.8)	66(74.2)	**1.89(1.21,2.94)**
Lower 3 quartiles (<18)	336(79.1)	46(13.7)	290(86.3)	Ref
Family resources scale: money subscale				
Quartile 1 (more)(5-9)	133(31.2)	13(9.8)	120(90.2)	Ref
Quartile 2 (10-14)	129(30.2)	20(15.5)	109(84.5)	1.59(0.82,3.05)
Quartile 3 (15-18)	97(22.7)	16(16.5)	81(83.5)	1.69(0.85,3.34)
Quartile 4 (less)(19-24)	68(15.9)	22(32.4)	46(67.7)	**3.31(1.78,6.15)**
Top quartile (≥19)	68(15.9)	22(32.4)	46(67.6)	**2.37(1.54,3.65)**
Lower 3 quartiles (<19)	359(84.1)	49(13.7)	310(86.3)	Ref
Maternal Psychosocial Factors (Moderators)				
Depressive symptoms				
CESD =>16	176(41.0)	40(22.7)	136(77.3)	**1.85(1.21,2.84)**
CESD <16	253(59.0)	31(12.3)	222(87.8)	Ref

Table 1 (cont'd)

Stress				
Quartile 1 (Less stress) (12-14)	116(27.4)	11(9.5)	105(90.5)	Ref
Quartile 2 (15-17)	114(26.9)	16(14.0)	98(86.0)	1.48(0.72,3.05)
Quartile 3 (18-21)	93(21.9)	18(19.4)	75(80.7)	**2.04(1.01,4.10)**
Quartile 4 (More stress) (22-39)	101(23.8)	24(23.8)	77(76.2)	**2.51(1.29,4.86)**
Top quartile (≥22)	101(23.8)	24(23.8)	77(76.2)	**1.71(1.10,2.65)**
Lower 3 quartiles (<22)	323(76.2)	45(13.9)	278(86.1)	Ref
Social support				
Quartile 1 (Low)(13-38)	84(19.6)	24(28.6)	60(71.4)	**2.00(1.17,3.42)**
Quartile 2 (39-47)	123(28.7)	19(15.5)	104(84.5)	1.08(0.60,1.94)
Quartile 3 (48-52)	89(20.8)	9(10.1)	80(89.9)	0.71(0.34,1.49)
Quartile 4 (High) (53-55)	133(31.0)	19(14.3)	114(85.7)	Ref
Quartile 1 (<39)	84(19.6)	24(28.6)	60(71.4)	**2.10(1.36,3.22)**
Quartiles 2-4 (≥39)	345(80.4)	47(13.6)	298(86.4)	Ref
Racism Lifetime experiences				
Quartile 1(Fewer experiences) (1-6)	79(18.4)	12(15.2)	67(84.8)	Ref
Quartile 2 (7-9)	101(23.5)	16(15.8)	85(84.2)	1.04(0.52,2.08)
Quartile 3 (10-13)	102((23.8)	16(15.7)	86(84.3)	1.03(0.52,2.06)
Quartile 4 (More experiences) (14-30)	147(34.3)	27(18.4)	120(81.6)	1.21(0.65,2.25)
Top quartile (≥14)	147(34.3)	27(18.4)	120(81.6)	1.18(0.76,1.82)
Lower 3 quartiles (<14)	282(65.7)	44(15.6)	238(84.4)	Ref

Abbreviations: **CI** = confidence interval, **Ref** = reference, **PR** = prevalence ratio
Bolded values indicate estimates with 95% CIs that do not cross the null value

Table 2: Distribution of Work factors by Preterm birth, Baltimore Study (N=429), 2001-2004

Work factors	Overall N(%)	Preterm N(%)	No Preterm N(%)
Work hours			
< 40 hrs/week	165(38.5)	33(20.0)	132(80.0)
40 hrs/week	239(55.7)	32(13.4)	207(86.6)
>40 hrs/week	25(5.8)	6(24.0)	19(76.0)
≤ 40hrs /week	404(94.2)	65(16.1)	339(83.9)
> 40hrs/week	25(5.8)	6(24.0)	19(76.0)
Physical demands measures			
Long periods with the body in physically awkward positions			
Yes	154(36.1)	20(13.0)	134(87.0)
No	273(63.9)	51(18.7)	222(81.3)
Long periods with head or arms in physically awkward positions			
Yes	130(30.4)	19(14.6)	111(85.4)
No	297(69.6)	52(17.5)	245(82.5)
Rapid and continuous physical activity			
Yes	287(67.1)	48(16.7)	239(83.3)
No	141(32.9)	23(16.3)	118(83.7)
Move or lift hefty loads			
Yes	145(33.9)	29(20.0)	116(80.0)
No	283(66.1)	42(14.8)	241(85.2)
Lots of physical effort			
Yes	331(77.3)	55(16.6)	276(83.4)
No	97(22.7)	16(16.5)	81(83.5)
Physical demands composite			
Median split			
High	216(50.4)	38(17.6)	178(82.4)
Low	213(49.6)	33(15.5)	180(84.5)
Quartiles			
Quartile 1 (Lowest demands) (5-10)	114(26.6)	18(15.8)	96(84.2)
Quartile 2 (11-12)	99(28.1)	15(15.2)	84(84.8)
Quartile 3 (13-14)	94(21.9)	17(18.1)	77(81.9)
Quartile 4 (Highest demands) (15-20)	122(28.4)	21(17.2)	101(82.8)
Top quartile	122(28.4)	21(17.2)	101(82.8)
Lower 3 quartiles	307(71.6)	50(16.3)	257(83.7)

Table 3: Univariate and multivariable analyses of Work factors (work hours, physical and psychological demands) and the risk of Preterm birth (N=429) 2001-2004

	Unadjusted Model	**Adjusted* Model**
	PR (95% CI)	**aPR (95% CI)**
Work hours		
< 40 hrs/week	1.49(0.96,2.33)	1.41(0.91,2.20)
40 hrs/week	Ref	
>40 hrs/week	1.79(0.83,3.87)	1.85(0.86,3.97)
>40hrs vs ≤40hrs/week	1.49 (0.72,3.10)	1.56(0.75,3.24)†
Physical demands measures		
Long periods with the body in physically awkward positions		
Yes vs No	0.70 (0.43,1.12)	0.67 (0.43,1.07)
Long periods with head or arms in physically awkward positions		
Yes vs No	0.83 (0.51,1.35)	0.83 (0.51,1.33)
Rapid and continuous physical activity		
Yes vs No	1.03 (0.65,1.62)	1.06 (0.67,1.67)
Move or lift hefty loads		
Yes vs No	1.35 (0.88,2.07)	1.33 (0.86,2.05)
Lots of physical effort		
Yes vs No	1.01 (0.61,1.68)	0.99 (0.59,1.64)
Physical demands composite		
Median split		
High vs Low physical demands	1.14 (0.74,1.74)	1.12 (0.74,1.70)
Quartiles		
1 (Lowest demands)	Ref	
2	0.96 (0.51,1.80)	0.81 (0.43,1.52)
3	1.15 (0.63,2.10)	0.99 (0.55,1.81)
4 (Highest demands)	1.09 (0.61,1.94)	1.03 (0.58,1.84)
Top quartile vs Lower quartiles	1.06 (0.66.1.68)	1.10 (0.68,1.78)

*Adjusted for Marital status/Cohabitation, Maternal age, education, Smoking during the second trimester, parity, and family money resources

†Adjusted for Marital status/Cohabitation, Maternal age, education, Smoking during the second trimester, parity, family money resources, and timing of recruitment

Abbreviations: **PR:** Prevalence Ratio **aPR:** Adjusted Prevalence Ratio **CI**: Confidence Interval **Ref:** Reference

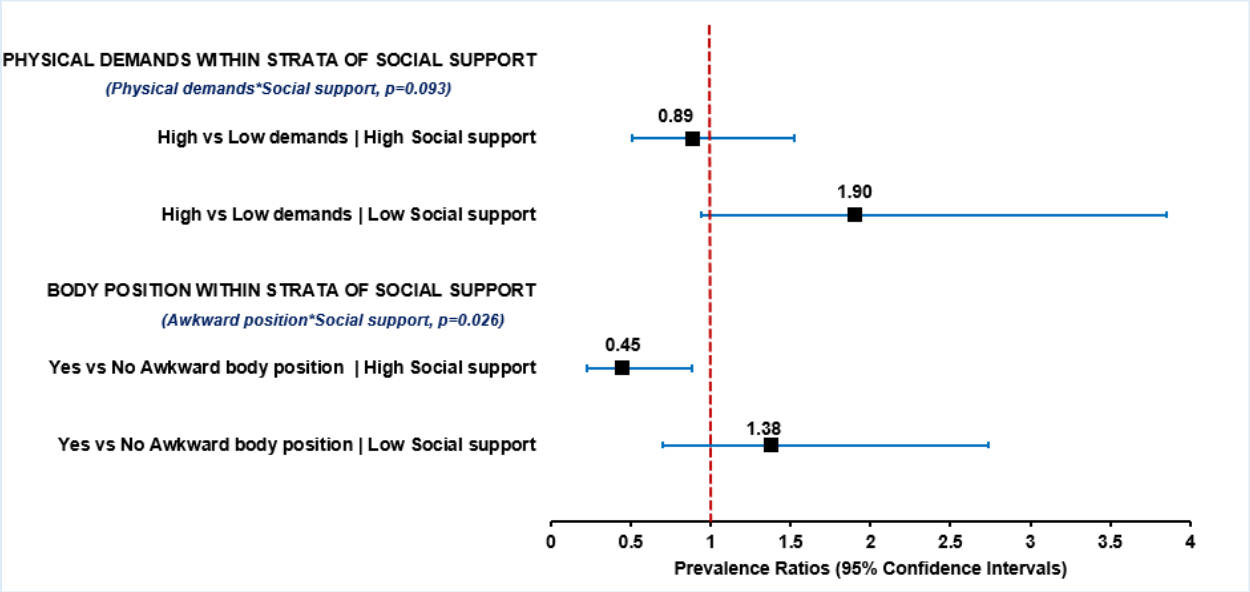
Table 4: Stratification analyses by timing of recruitment

	Prenatal recruitment		**Postpartum recruitment**	
	Unadjusted PR(95% CI)	**Adjusted aPR(95% CI**	**Unadjusted PR(95% CI)**	**Adjusted* aPR(95% CI)**
Work hours				
> 40hrs /week	1.04(0.29,3.82)	1.29(0.35,4.65)	1.89(0.78,4.59)	**2.65(1.00,7.01)**
≤ 40hrs/week	Ref			
Physical demands composite				
Median split				
High vs Low physical demands	1.21(0.69,2.13)	1.12(0.66,1.92)	1.02(0.53,1.95)	0.92(0.47,1.78)
Quartiles				
1 (Lowest demands)	Ref			
2	0.49(0.20,1.20)	0.41(0.17,0.99)	2.64(0.89,7.82)	2.40(0.80,7.18)
3	1.00(0.47,2.12)	0.74(0.35,1.58)	1.74(0.57,5.37)	1.51(0.49,4.67)
4 (Highest demands)	0.87(0.42,1.78)	0.80(0.40,1.59)	1.83(0.62,5.43)	1.57(0.52,4.76)
Top quartile vs Lower 3 quartiles	1.06(0.56,1.99)	1.08(0.57,2.07)	1.05(0.53,2.07)	0.98(0.49,1.98)

*Adjusted for Marital status, Maternal age, education, smoking during the second trimester, parity, and family money resources

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval **Ref:** Reference

Figure 1: Physical demands related differences in risk of preterm birth within strata of social support



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APPENDIX A

Supplementary Tables (S1 – S5)

Table S1: Work factors (physical demands, work hours) related differences within strata of social support

Model terms	Stratum	Work factor aPR* (95% CI)	Interaction *P*-value
Physical demands and social support			
Awkward body position*social support	High social support	**0.45(0.23,0.88)**	***P* = 0.026**
	Low social support	1.38(0.70,2.74)	
Awkward head/arms position*social support	High social support	0.69(0.36,1.30)	*P* = 0.228
	Low social support	1.26(0.61,2.59)	
Rapid physical activity *social support	High social support	0.93(0.53,1.62)	*P* = 0.506
	Low social support	1.28(0.59,2.78)	
Heavy lifting*social support	High social support	1.32(0.76,2.28)	*P* = 0.998
	Low social support	1.32(0.67,2.61)	
Physical effort*social support	High social support	0.92(0.49,1.74)	*P* = 0.604
	Low social support	1.21(0.53,2.73)	
Physical demands composite median*social support	High social support	0.89(0.51,1.52)	***P* = 0.093**
	Low social support	1.90(0.94,3.85)	
Physical demands composite quartile*social support	High social support	1.09(0.60,1.99)	*P* = 0.919
	Low social support	1.04(0.48,2.28)	
Work hours and social support			
Work hours*social support	High social support	1.17(0.40,3.41)	*P* = 0.393
	Low social support	2.17(0.86,5.48)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S2: Work factors (physical demands, work hours) related differences within strata of depression

Model terms	Stratum	Work factor aPR*(95% CI)	Interaction *P*-value
Physical demands and depression			
Body position*depression	High depression	0.70(0.39,1.25)	*P* = 0.727
	Low depression	0.58(0.26,1.31)	
Head/arms in awkward position*depression	High depression	0.91(0.51,1.63)	*P* = 0.523
	Low depression	0.65(0.28,1.53)	
Rapid physical activity*depression	High depression	1.26(0.70,2.27)	*P* = 0.393
	Low depression	0.85(0.43,1.70)	
Heavy lifting*depression	High depression	1.52(0.89,2.60)	*P* = 0.324
	Low depression	0.97(0.47,2.03)	
Physical effort*depression	High depression	1.22(0.60,2.51)	*P* = 0.351
	Low depression	0.75(0.36,1.56)	
Physical demands composite median*depression	High depression	1.14(0.66,1.96)	*P* = 0.797
	Low depression	1.01(0.52,1.99)	
Physical demands composite quartile*depression	High depression	1.19(0.67,2.11)	*P* = 0.471
	Low depression	0.82(0.35,1.92)	
Work hours and depression			
Work hours*depression	High depression	2.01(0.91,4.43)	*P* = 0.225
	Low depression	0.65(0.10,4.39)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S3: Work factors (physical demands, work hours) related differences within strata of stress

Model terms	Stratum	Work factor aPR* (95% CI)	Interaction *P*-value
Physical demands and stress			
Body in awkward position*stress	High stress	0.53(0.23,1.21)	*P* = 0.635
	Low stress	0.68(0.37,1.25)	
Head/arms in awkward position*stress	High stress	0.80(0.37,1.73)	*P* = 0.851
	Low stress	0.72(0.37,1.40)	
Rapid physical activity*stress	High stress	1.55(0.68,3.53)	*P* = 0.208
	Low stress	0.84(0.48,1.46)	
Heavy lifting*stress	High stress	1.38(0.67,2.84)	
	Low stress	1.19(0.68,2.09)	*P* = 0.742
Physical effort*stress	High stress	0.95(0.44,2.07)	
	Low stress	1.02(0.52,2.03)	*P* = 0.887
Physical demands composite median*stress	High stress	1.10(0.54,2.23)	
	Low stress	1.08(0.63,1.86)	*P* = 0.974
Physical demands composite quartile*stress	High stress	0.96(0.43,2.12)	
	Low stress	1.01(0.53,1.92)	*P* = 0.920
Work hours and stress			
Work hours*stress	High stress	2.19(0.83,5.80)	
	Low stress	0.82(0.22,3.10)	*P* = 0.230

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S4: Work factors (physical demands, work hours) related differences within strata of racism

Model terms	Stratum	Work factor aPR* (95% CI)	Interaction *P*-value
Physical demands and racism			
Body in awkward position*racism	High racism	0.71(0.34,1.50)	*P* = 0.853
	Low racism	0.65(0.35,1.18)	
Head/arms in awkward position*racism	High racism	0.55(0.24,1.26)	*P* = 0.224
	Low racism	1.01(0.57,1.81)	
Rapid physical activity *racism	High racism	1.45(0.68,3.08)	*P* = 0.316
	Low racism	0.90(0.52,1.57)	
Heavy lifting*racism	High racism	0.85(0.40,1.82)	*P* = 0.140
	Low racism	1.68(0.98,2.87)	
Physical effort*racism	High racism	1.36(0.60,3.11)	*P* = 0.339
	Low racism	0.83(0.44,1.55)	
Physical demands median*racism	High racism	1.34(0.67,2.69)	*P* = 0.530
	Low racism	1.01(0.60,1.72)	
Physical demands quartile*racism	High racism	0.92(0.42,2.02)	
	Low racism	1.21(0.67,2.20)	*P* = 0.572
Work hours and racism			
Work hours*stress	High racism	1.45(0.51,4.11)	
	Low racism	1.53(0.55,4.28)	*P* = 0.944

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

CHAPTER 5: PSYCHOLOGICAL DEMANDS OF WORK AND RISK OF PRETERM BIRTH AMONG BLACK WOMEN (MANUSCRIPT 2)

Abstract

Background: Preterm birth (PTB) contributes to most neonatal mortality, morbidity, and long-term neurological disabilities and is the leading cause of infant mortality among Black infants. While many potential risk factors for PTB in the prenatal environment have been extensively studied, little is known about the relationship between workplace exposures and experiences during pregnancy and PTB. Our study objectives were to determine the prevalence of psychological demands of work, examine the role of psychological demands in the work environment on the risk of PTB among Black mothers, and identify potential moderators of any associations.

Methods: We utilized data from a cohort study of Black women residing in Baltimore (2001-2004) that recruited and interviewed 872 women. We restricted our study to the 429 formally employed during pregnancy. Psychological demands of the prenatal work environment were assessed (subscale of Karasek Job Demands and Control) by comparing the top quartile and the bottom 3 quartiles. Individual items from the sub-scale were also analyzed as dichotomous variables (strongly agree/agree vs. strongly disagree/disagree). We used log-binomial regression analyses to evaluate the association between psychological demands and PTB and to adjust for the potential covariates. On a multiplicative scale, we explored potential moderators (psychosocial factors and lifetime experiences of racism) using a cut-point of $p< 0.10$. Moderators were modeled as the top quartile vs. bottom 3 quartiles of each scale, except depressive symptoms (Center for Epidemiologic Studies scale ≥16 vs <16). Results are presented as prevalence ratios (PR) and 95% Confidence Intervals (95% CI).

Results: Among employed women, 16.6% experienced PTB. We observed a significant association between high psychological demands (top quartile vs. lower three quartiles) and PTB (aPR=1.82; 95% CI:1.20,2.76). Social support (*psychological demand*social support p=0.01*) and depressive symptoms (*psychological demand*depressive symptoms p=0.02*) moderated the relationships between high psychological demands and PTB. High psychologically demanding work was significantly associated with increased PTB rates among women with low social support (aPR: 1.92; 95% CI:1.16,3.17) and among women with high depressive symptoms (aPR: 1.99; 95% CI:1.12,3.52). Prevalence ratios were greatest for women whose jobs required being asked to do an excessive amount of work (aPR=1.32; 95% CI: 0.84,2.07) or who did not have enough time to complete their work (aPR=1.49; 95% CI: 0.92,2.42). Depressive symptoms moderated the relationships between working very hectic jobs and PTB (*hectic*depressive symptoms p=0.02*). Social support moderated the relationship between working very hard and PTB (*working hard*social support p=0.03*). Working with intense concentration and PTB association was moderated by stress (*intense concentration*stress* p=0.02) and social support (*intense concentration*social support p=0.09*).

Conclusion: Black women whose work involves psychologically demanding activities are at elevated risk of PTB, with evidence of interactions with other predictors for PTB. Intervention efforts could focus on psychological work exposures and these interaction factors. Findings highlight the need for interventions that provide an accommodative work environment for pregnant women to ensure better pregnancy outcomes.

PTB: Preterm birth; **aPR:** Adjusted prevalence ratio **CI**: Confidence intervals

5.1 Introduction

Preterm birth (PTB, <37 weeks' gestation) accounts for nearly 15 million babies born globally each year[1] and is a leading cause of neonatal mortality, morbidity, and long-term neurological disabilities.[2] In the United States (US), PTB affects 1 of every 10 infants born.[3] Black women are more likely than non-Hispanic White women to experience PTB (14.6% vs. 9.4% in 2022), and it is the leading cause of infant mortality among Black infants.[3,4] Infants who survive may experience cerebral palsy, developmental delays, vision, hearing problems, and cardiovascular disease during adulthood.[3,5–7] Existing research has explored and reported associations between PTB and characteristics such as education, socioeconomic status, and smoking. Still, these factors do not fully account for the burden of PTB among Black women, highlighting the need to explore additional contributing factors.

In the US, women have always been part of the workforce;[8–10] however, the proportion of working women has increased over the years, and the majority continue working during pregnancy.[11–13] Women continue working while pregnant for various reasons, including professional fulfillment, economic necessity, access to health insurance, and paid leave benefits, which are lost without employment. However, working during pregnancy can also expose women to work-related stresses that may increase the risk of PTB for some women. In non-pregnant individuals, prior studies have investigated the effect of the psychosocial stresses of the work environment on hypertension, cardiovascular disease[14–17], and musculoskeletal disorders.[18,19] Among pregnant women, a handful of studies have examined the effect of the psychosocial work environment on PTB.[20–29] However, findings have been inconsistent due to

variations in the measurement of the psychosocial work environment factors, sample size, low response rates, and inadequate adjustment of potential confounders. Most of these studies have considered psychological job demands along with the level of control women may have in their work environment.[20,22,25–29] Only two studies, Escriba-Aguir et al. in a case-control study[24] and Meyer et al. in a US cross-sectional study[23], considered the effect of psychological demands of the work environment on PTB separate from the worker's control. Furthermore, no published studies have examined the effect of psychological demands on PTB among Black women. To address this gap, we analyzed data from a large Black-only cohort that included exposures such as racism that are distinctive to Black women. Further, factors like stress, depressive symptoms, social support, and racism, which have been reported to be associated with PTB, may interact with the psychological demands of the workplace. A few prior studies have examined moderation by race but not by racism or psychosocial factors.[27,30] These factors are important to Black women and have been reported to be important moderators in previous studies on birth outcomes.[31–33] They may influence a woman's physiological and psychological resilience during pregnancy and further compound the challenges of managing workplace demands.

Our study objective was to: 1) describe the prevalence of psychological work demands during pregnancy in a cohort of Black women; 2) evaluate the associations between psychological demands of work and PTB; 3) determine whether levels of depressive symptoms, social support, perceived stress, and lifetime experiences of racism modify the association between psychological demands and PTB.

5.2 Methods

5.2.1 Design, Data, and Study Population

We utilized data from the Baltimore study, a hybrid cohort study of Black women in Baltimore, Maryland, USA.[32] Women who self-identified as Black, resided in Baltimore, and received prenatal care at one of the three Johns Hopkins Medical Institution (JHMI) prenatal clinics (prospective) or had their babies born at the JHMI hospital (retrospective) were eligible to be enrolled into the study. Eight hundred seventy-two were enrolled and interviewed during the recruitment period (2001-2004) with a response rate of 68 percent. Recruitment for this study was done prenatally (485 women) and postpartum (387 women). Women enrolled prenatally were interviewed at 22-28 weeks of gestation and received a short postpartum interview. Women enrolled postpartum were interviewed only at enrollment.[32] Information on sociodemographic factors, psychosocial factors, and health behaviors was obtained using in-person interviews. Trained personnel abstracted prenatal and delivery medical records to obtain data for gestation age, presence of chronic diseases, and any pregnancy complications. For this study, after excluding multiple births (n = 24) and losses to follow-up (n = 16), 832 participants had medical record data on the pregnancy and birth, and our analysis focused on women employed during pregnancy (N=429). We had a small proportion of missing data on any single variable studied (<2%), so imputation of missing data was deemed unnecessary.[34]

Ethical approval

The parent study was evaluated and authorized by institutional review boards at the relevant institutions.[32]

5.2.2 Measures

5.2.2.1 Outcome: Preterm Birth (PTB)

Preterm birth, defined as birth before 37 completed weeks of gestation,[35] was the primary outcome of our study. Measures of gestational age at delivery (including early ultrasound and last menstrual period) were abstracted from the medical record with a hierarchical algorithm to determine the most accurate gestational age at delivery.[36]

5.2.2.2 Work Exposure: Psychological Demands

Psychological demands were measured using eight relevant Job Demands and Control (JDC)[37] items (working very fast, long periods of intense concentration, conflicting demands, very hectic, working very hard, tasks often interrupted, excessive amount of work, and not enough time to get the job done). Each item consists of a statement, and the respondent was asked to ascertain how much they agree. Responses range from 1 (strongly disagree) to 4 (strongly agree). Items were summed to create a single, continuous variable, with lower values correlating to lower demands, and both median splits and quartiles were used to construct categorical variables. Finally, individual items were dichotomized (Yes: strongly agree/agree vs. No: strongly disagree/disagree) to model as individual exposures (psychological demands measures).

5.2.2.3 Covariates

Covariates were considered potential confounders if identified as confounders in the literature on workplace exposures and/or PTB.[38–43] We considered maternal characteristics (maternal education, age, marital/cohabiting status, behavior, adequacy of resources, and parity) as potential covariates.

In-person interviews were used to obtain information on age and marital status. Age was measured as a continuous variable, and we created 4 age groups (≤19; 20-24,

25-29, 30+), and we used 25-29 years as the reference. Women were asked if they were married, cohabiting, or single. We combined the married and cohabiting groups for our study and used the single group as our reference. Education was measured as a continuous variable indicating the highest grade/year of school completed. For our study, we created three groups: Less than high school, high school diploma / GED and beyond high school; we used less than high school as our reference. A brief set of standard questions measured smoking to determine lifetime exposure and exposure to smoking by trimester (yes/no, amount) and cessation. The Family Resources Scale[44] (FRS), a 25-item instrument was used to assess the adequacy of family resources in terms of time and money[44,45]. Women reported on how often they had specific resources (e.g., “enough money to buy food for two meals a day while pregnant,” “enough money to pay monthly bills”). Responses were measured using a Likert scale ranging from 1 (almost always) to 5 (almost never). Lower values indicate greater family resources. We summed the items to create a continuous variable and constructed quartiles for further analysis. Parity (1 previous live birth or ≥2 previous live births vs. no previous live births) was obtained using the medical history abstraction instrument and confirmed with the maternal interview.

5.2.2.4 Moderators

Four factors were *a priori* conceptualized as potential moderators of the psychological demands-PTB associations: depressive symptoms, stress, social support, and lifetime experiences of racism. We considered these factors because they are important for Black women’s lives, there is variation in the analytic sample, and they are associated with PTB.

Depressive symptoms were measured by the 20-item Center for Epidemiologic Studies Depression Scale (CES-D, Cronbach's α = 0.89).[46,47] Respondents were asked to think about how often they experienced symptoms in the past week. Items were scored from 0 (rarely/never) to 3 (most of the time). Items were summed to generate a continuous variable, and then a dichotomous variable was created for further analysis. The ≥16 cut point, which has been frequently used to indicate a likely diagnosis of depression,[32] was utilized for the analysis.

Stress was measured using the Prenatal Psychosocial Profile Hassles Scale,[48,49] a 12-item scale with a Cronbach's α of 0.81[44]. Respondents were asked to indicate to what extent things that occurred during pregnancy made them stressed. Examples include "worries about food, shelter, health care, and transportation,' 'money worries like paying bills,' 'problems related to family,' 'having to move,' either recently or in the future,' 'a recent loss of a loved one sexual,' 'emotional or physical abuse' etc. This scale utilizes a 4-point response for each item and ranges from 1(no stress) to 4(severe). Items were summed to create a single, continuous variable, and quartiles were utilized to construct a categorical variable for analysis.

Social support was measured by a shortened Medical Outcomes Study Social Support Survey,[50], an 11-item scale (Cronbach's alpha= 0.90). We considered the dimensions of social and emotional support as global measures and were not specific to being within or outside the workplace. Respondents were asked how often specific kinds of support were available to them when they needed it. Examples include "someone you can count on to listen when you need to talk', 'someone to help with daily chores if you were sick,' 'someone to take you to the doctor if you needed it,' and 'someone to love and make

you feel wanted'. Responses ranged from 1 (none of the time) to 4 (most of the time), with lower values indicative of less social support. Items were summed to create a single, continuous variable, and quartiles were used to construct a categorical variable for further analysis.

Racism life experiences: The Racism and Life Experiences Scale-Brief Version (RaLES-BRF) constructed by Harrell[51–53] was used to assess lifetime experiences with racism. The 9-item scale with Likert responses assesses lifetime exposure to racism broadly (e.g., "In general, how frequently do you hear about incidents of racial prejudice, discrimination, or racism from family, friends, co-workers, neighbors, etc."). The scale's psychometric properties have demonstrated high reliability and strong construct validity.[54] Items were summed up to create a continuous variable for experiences of racism, and quartiles were constructed for further analysis.

5.2.3 Statistical Analysis

We summarized descriptive characteristics of the study population using frequencies and percentages. Using log-binomial regression models, we conducted bivariate and multivariable analyses to estimate prevalence ratios (PR) and their corresponding 95% confidence intervals (95% CI).[55,56] We utilized log-binomial models to estimate PRs instead of logistic regression since the PTB rate in the cohort (16.6%) was indicative of a common outcome in this population.[57] A p-value of <0.25[58] for the unadjusted associations was considered suggestive of potential significance. In multivariable analyses, we utilized a forward stepwise approach, starting with the unadjusted models that had psychological demands measures, followed by models adjusting for sociodemographic, behavioral factors, parity, and adequacy of family resources. We hypothesized that social and psychosocial factors were likely to modify the effects of

work on PTB. We explored moderation on a multiplicative scale by adding an interaction term between the exposure and the potential moderator to the adjusted regression models. We compared the likelihood ratios (LRs) to determine whether the model with interactions provided a better fit to the data than the model without them. We determined the significance of the interaction terms using the Likelihood Ratio (LR) chi-square test and a p-value less than 0.10. All analyses were conducted using SAS software, version 9.4 (SAS Institute, Cary, NC).

5.3 Results

The mean age for the participants was 24 years. Of the 429 participants, 71(16.6%) had PTB, 41% experienced a high level of depressive symptoms, 50% were married or cohabiting, and 86% of the women had a GED or Diploma as the highest educational attainment (Table 1).

Table 2 shows the distribution of psychological demands by PTB. Approximately 44% of the women had psychologically demanding jobs based on the summary measures of psychological demands.

We observed associations between non-work factors and PTB in bivariate analyses. (Table 1): smoking in the second trimester; unmet needs (less resources) regarding time and money; high levels of depressive symptoms; high stress; and low social support.

We observed a significant association between the highest scores on the psychological demands construct (top quartile vs. lower three quartiles) and PTB and a modest, non-significant association between demands above the median score and PTB. Individual

psychological demands scale items were not significantly associated with PTB. (Table 3).

Overall, women scoring in the top quartile (highest) of the psychological demands construct had significantly increased PTB rates (aPR=1.82; 95% CI:1.20,2.76) compared to women scoring in the lower three quartiles after controlling for confounders. High-demanding (above median) work compared to low-demanding work was positively associated with PTB, but the confidence interval, while narrow, included 1 (aPR=1.36; 95% CI:0.90,2.10). None of the individual measures for the psychological demands were associated with significant PTB increases regardless of covariate adjustment (Table 3). PRs were greatest for women whose jobs required being asked to do an excessive amount of work (aPR = 1.32; 95% CI: 0.84,2.07) or who did not have enough time to complete the job (aPR = 1.49; 95% CI: 0.92,2.42) but confidence intervals included the null value of 1 (Table 3).

Moderation

Figures 1-3 and supplementary tables (S1- S4) show the results of the moderation analyses on the multiplicative scale.

Psychological demands construct

Social support moderated the relationship between high psychological demands and PTB (*psychological demand*social support p =0.007*). Among women with low social support, having a job with high psychological demands was significantly associated with increased PTB rates (aPR: 1.92; 95% CI:1.16,3.17). Among women with high social support, having a job with high psychological demands was associated

with lower non-statistically significant PTB rates (aPR: 0.48; 95% CI: 0.18,1.25). (Figure 1, Table S1).

Depression moderated the relationship between high psychological demands and PTB (*psychological demand*depressive symptoms p =0.024*). Among women with high depression, having a job with high psychological demands was significantly associated with increased PTB rates (aPR: 1.99; 95% CI:1.12,3.52). Among women with low depression, having a job with high psychological demands was associated with lower non-significant PTB rates (aPR: 0.72; 95% CI:0.35,1.46) (Figure 1, Table S2).

Racism did not moderate the relationship between psychological demands and PTB (Table S4).

Psychological demands individual measures

Three of the individual psychological demands measures (i.e., working very hard, working long periods with intense concentration, and working very hectic jobs) were moderated by psychosocial factors (i.e., social support, depression, and stress). Again, racism was not a moderator of the individual measures of psychological demands.

Working very hard

Social support moderated the relationship between working very hard and PTB (*working hard*social support p = 0.030*). Among women with low social support, working very hard was positively associated with PTB, but the confidence interval included the null value of 1 (aPR: 1.33; 95% CI: 0.67, 2.64). Among women with high social support, working very hard was significantly associated with a lower risk of PTB (aPR: 0.37; 95% CI: 0.16, 0.86) (Figure 2, Table S1).

Working long periods with intense concentration

Social support moderated the relationship between working long periods with intense concentration and PTB (*intense concentration*social support p =0.094*). Among women with low social support, working long periods with intense concentration was positively associated with PTB (aPR: 1.57; 95% CI: 0.91, 2.70), although not statistically significant. Among women with high social support, working long periods with intense concentration was associated with lower non-significant PTB rates (aPR: 0.66; 95% CI: 0.29, 1.50) (Figure 2, Table S1).

Stress moderated the relationship between working long periods with intense concentration and PTB (*intense concentration*stress p = 0.015*). Among women with high stress, having a job that requires intense concentration was significantly associated with PTB (aPR: 3.25; 95% CI: 1.04, 10.20). Further, women with less stress had lower PTB rates (aPR: 0.81; 95% CI: 0.47,1.39), but the confidence interval included a null value of 1 (Figure 3, Table S3).

Working very hectic jobs

High depression moderated the relationship between working very hectic jobs and PTB (*hectic*depressive symptoms p=0.015*). Among women with high depression, having a very hectic job was positively associated with PTB (aPR: 1.22; 95% CI: 0.69,2.18), but the confidence interval included the null value of 1. However, among women with low depression, having a hectic job was associated with lower PTB rates (aPR: 0.40; 95% CI: 0.20,0.82) (Figure 3, Table S2).

5.4 Discussion

How psychosocial stressors in a work environment impact the risk of PTB has not been extensively studied, especially among Black women, the group at highest risk of PTB. A recent meta-analysis[59] identified ten papers,[20–29] of which just three[22,23,27] focused on U.S. populations, and only two studies[23,24] considered the psychological demands of work separate from job control. The three U.S. studies[22,23,27] were the only ones that included any Black women. Even so, two studies[22,23] did not report on the stratified results by maternal race and treated race as a confounder. In our study, we aimed to determine the prevalence of work characteristics, evaluate the effect of psychological demands of work on the risk of PTB, and determine whether this association was moderated by psychosocial factors (depressive symptoms, stress, social support) and lifetime experiences of racism among Black women.

5.4.1 Prevalence of PTB and psychological demands

More than 16 percent of births in our study population were preterm, indicating a high burden of PTB for this cohort of Black women. Our sample also had a high prevalence of demanding working environments, with 44% scored as having high psychologically demanding work. Our prevalence is comparable with Meyer et al.,[23] in a US study that included data for Black women and reported a 48% prevalence of psychologically demanding jobs for Black women. In the other two publications that included data from Black women, neither reported on the prevalence of exposure overall or for Black women.[22,27]

5.4.2 Psychological demands composite

In our study, having the highest psychologically demanding work (top quartile vs.

lower three quartiles) was significantly associated with PTB. Women with the highest psychological demands in their work may also have low control of their work. Jobs that are highly demanding but with limited control for pregnant women have been associated with adverse birth outcomes, including PTB.[23,27,28] We did not examine women's control over their work in our current study but plan to do so in our future studies. It is also worth noting that in addition to the demands at their workplace, most women may also juggle household chores like cooking and taking care of their children or elderly parents, and some may be taking care of multiple children, which may increase their risk of PTB.

Our findings contradict those from studies by Escriba-Aguir et al.[24] and Meyer et al. [23] which reported non-significant associations between psychological demands and PTB. Escriba-Aguir et al.,[24] in a case-control study reported a positive, non-significant association between psychological demands and PTB (OR=1.46; 95% CI: 0.95, 2.26).[24] However, this study utilized only four questions for their psychological demands indicator (work at high speed, work to tight deadlines, too simple work, and repetitive or monotonous work), while our study utilized the eight JDC[37] items for the psychological demands indicator. Further, Escriba-Aguir et al.,[24] used the four questions to create a psychological demands indicator and compared two categories (high vs. low), but our study compared median split (high vs. low) and quartiles. Meyer et al.[23] did utilize the full JDC but reported no association between high psychological demands and PTB (OR=0.95; 95% CI: 0.85, 1.05). Although Meyer et al.[23] included data for Black women, they did not report on the stratified results by maternal race and considered race as a confounder.

5.4.3 Psychological demands individual measures

Further analysis considered individual items within the subscale of psychological demands. We found that having a job characterized by excessive work and not having enough time to complete work were modestly associated with PTB, but the associations were not statistically significant. Women who reported excessive work or reported not having enough time to complete their work may have low control over their work. Women working in such conditions may experience elevated stress and depressive symptoms, increasing their vulnerability to PTB. Prior studies have indicated a PTB association with jobs characterized by high demands and low control.[23,27] We did not find any appreciable associations between other specific psychological demands (working very fast, working very hard, conflicting demands, long periods of intense concentration, tasks often interrupted, and very hectic work) examined as separate exposures with PTB. None of the published research on workplace psychological demands and PTB analyzed the individual items, so our work fills a gap in the literature.

The inconsistent findings from past studies that have evaluated psychological demands in the work environment and PTB may be due to variations in the measurement of the psychosocial work environment, sample size, low response rates, population studied, and inadequate adjustment of potential confounders. Most prior studies considered psychological job demands in concert with the level of control women have in their work environment.[20,22,25–29] Only two studies, Escriba-Aguir et al. (Spain case-control study)[24] and Meyer et al. (U.S. cross-sectional study),[23] reported on psychological job demands on PTB separate from the control of the worker. Our study is the second, after Meyer et al., to utilize the JDC[37] questionnaire to assess the individual

effect of psychological work conditions on PTB risk. Our study is also the first to evaluate the psychological demands of work in a cohort of Black women.

Moderation

In contrast to all publications identified, we also explored the potential for moderation by other psychosocial factors that are known predictors of PTB. Our results suggest that psychosocial factors are indeed important moderators of psychological work demands and risk of PTB.

These findings are unique to our study as no published studies examining the association between psychological demands and PTB have reported on how psychosocial factors could affect this association. Our findings suggest that high social support and low depressive symptoms may buffer the effects of psychologically demanding work on PTB, and low social support, high depressive symptoms, and high stress may amplify the effect of psychological demands on PTB. Psychologically demanding work may make women more susceptible to depressive symptoms and stress, hence increasing their risk for PTB. It is possible that high stress may result in some women engaging in habits like smoking as a coping mechanism and may lead to high blood pressure. These factors (smoking, elevated blood pressure) make these women more vulnerable to PTB.[60,61] On the other hand, high social support through positive interactions with one's networks outside the workplace may alleviate psychologically demanding work-related stress.[62] High social support may also be a coping mechanism as pregnant women receive assistance with other demands outside of work like household chores, childcare, and prenatal care visits.[62,63]

Our study findings suggest that the effect of the individual measures of psychological demands on PTB risk may be missed if we fail to consider non-work psychosocial risk and protective factors in pregnancy. Psychosocial factors have been studied outside of the workplace environment and found to be associated with PTB.[64,65] They have not been studied in relation to the psychological demands of work and the PTB association.[31–33] Future studies should consider how psychosocial factors may be interrelated with psychological demands in the work environment.

There was no moderation seen for the psychological demands-PTB association by racism. Our study had 86% of the women aged ≤ 29 years; it is possible that this may have been a limitation for our study to capture the effects of lifetime experiences of racism, as such experiences may greatly impact older women who have been exposed for a longer period.[32] Further, racism experiences may be important in the workplace context for PTB, but our specific measure may not have captured them. In our future studies, we will consider evaluating racism experiences specific to the workplace to capture the effect of racism.

Strengths

Our study utilized data from a large cohort of Black women who experience the highest burden of PTB risk. These women are also predominantly low-income. Investigating the impact of psychological demands of work on PTB provides novel empirical evidence on the role of stresses in the work environment on PTB among Black mothers. We utilized robust analytic methods that leveraged the rich contextual data of our study, particularly social and psychosocial measures. Previous studies have not evaluated the moderating role of psychosocial factors when assessing the association between exposures in the

work environment and PTB. The findings from this study suggest that depressive symptoms, stress, and social support are moderators.

Worth noting is the parent study design and data collection techniques that were utilized. The parent study recruited women prenatally and postpartum. Postpartum recruitment included women with late, no prenatal care, and sporadic care, hence increasing the generalizability of our study findings[66] and reducing potential selection biases.[67–71] Much as postpartum recruitment poses the challenge of recall bias, there was limited evidence for recall bias concerning mothers' pregnancy exposures.[72–77] Further, the parent study provided extensive data on key covariates that are known predictors of PTB including health behaviors, that are not usually collected in studies that have examined the effect of exposures in the work environment on pregnancy outcomes. Our study utilized interviews to obtain data on health behaviors which is similar to other studies that have included Black women.[27,30,78] Utilizing interviews provides nuanced data that may not be collected by studies that rely on birth certificates or medical records alone.[79]

Limitations

Our study was a secondary analysis of cross-sectional data, and thus the temporal relation between exposure and outcome may limit inference. Moreover, the parent study was conducted in the early 2000s. While there has been little change in PTB rates for Black women in the past two decades, we cannot ignore the evolution of the work environment. These changes may affect the prevalence of psychologically demanding work for Black women. Our future studies will evaluate the changes that may have occurred in the work environment. However, despite the limitations, these are the only

available data with Karasek's psychological demand measures, PTB, and the rich data that was key in exploring the moderating role of psychosocial factors.

Significance

Our study provides novel empirical evidence on how psychological demands of work impact PTB risk among Black women. These findings are beneficial in raising public health awareness of pregnant women on the impact of stresses in the work environment on pregnancy outcomes. This evidence can be utilized in developing workplace policies to support the health of pregnant women, especially Black women who are at elevated risk of PTB. Further, our findings add to the evidence of the impact of work exposures on pregnancy outcomes and can be utilized to support the incorporation of accommodations for pregnant women in the work environment, which would align with the US 2024 Pregnant Fair Workers Act.[80]

5.5 Conclusion

Black women whose work involves psychologically demanding work activities are at elevated risk of PTB with evidence of interactions with other predictors for PTB. There is a need to develop intervention efforts that address psychological work exposures and these factors. The findings highlight the need for measures that provide an accommodative work environment for pregnant women to ensure better pregnancy outcomes.

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5.6 Tables and Figures

Table 1: Distribution of maternal characteristics: univariate and bivariate distributions with preterm birth, Baltimore Study (N=429), 2001-2004

	Total Sample N(%)	Preterm N(%)	No Preterm N(%)	Crude PR (95% CI)
Maternal factors				
Maternal age (Years)				
≤19	79(18.4)	16(20.3)	63(79.8)	1.54(0.79,3.01)
20-24	190(44.3)	29(15.3)	161(84.7)	1.16(0.63,2.13)
25-29	99(23.1)	13(13.1)	86(86.9)	Ref
30+	61(14.2)	13(21.3)	48(78.7)	1.62(0.81,3.27)
Maternal Education				
Less than High school	144(33.6)	24(16.7)	120(83.3)	Ref
High school diploma /GED	225(52.4)	37(16.4)	188(83.6)	0.99(0.62,1.58)
Beyond high school	60(14.0)	10(16.7)	50(83.3)	1.00(0.51,1.96)
Married/Cohabiting				
Yes	213(49.7)	37(17.4)	176(82.6)	1.10(0.72,1.69)
No	216(50.3)	34(15.7)	182(84.3)	Ref
Smoked during the second trimester				
Yes	73(17.1)	18(24.7)	55(75.3)	**1.68(1.05,2.69)**
No	354(82.9)	52(14.7)	302(85.3)	Ref
Parity				
≥ 1 previous live births	285(66.4)	47(16.5)	238(83.5)	0.99(0.63,1.55)
No previous live births	144(33.6)	24(16.7)	120(83.3)	Ref
Family resources scale: Nonessential time subscale				
Quartile 1 (more)(7-9)	124(29.2)	15(12.1)	109(87.9)	Ref
Quartile 2 (10-12)	102(24.0)	11(10.8)	91(89.2)	0.89(0.43,1.85)
Quartile 3 (13-17)	110(25.9)	20(18.2)	90(81.8)	1.50(0.81,2.79)
Quartile 4 (less)(18-35)	89(20.9)	23(25.8)	66(74.2)	**2.14(1.18,3.86)**
Top quartile (≥18)	89(20.9)	23(25.8)	66(74.2)	**1.89(1.21,2.94)**
Lower 3 quartiles (<18)	336(79.1)	46(13.7)	290(86.3)	Ref
Family resources scale: Nonessential money subscale				
Quartile 1 (more)(5-9)	133(31.2)	13(9.8)	120(90.2)	Ref
Quartile 2 (10-14)	129(30.2)	20(15.5)	109(84.5)	1.59(0.82,3.05)
Quartile 3 (15-18)	97(22.7)	16(16.5)	81(83.5)	1.69(0.85,3.34)
Quartile 4 (less)(19-24)	68(15.9)	22(32.4)	46(67.7)	**3.31(1.78,6.15)**
Top quartile (≥19)	68(15.9)	22(32.4)	46(67.6)	**2.37(1.54,3.65)**
Lower 3 quartiles (<19)	359(84.1)	49(13.7)	310(86.3)	Ref
Maternal Factors (Moderators)				
Depressive symptoms				
CESD =>16	176(41.0)	40(22.7)	136(77.3)	**1.85(1.21,2.84)**
CESD <16	253(59.0)	31(12.3)	222(87.8)	Ref

Table 1 (cont'd)

Stress				
Quartile 1 (Less stress) (12-14)	116(27.4)	11(9.5)	105(90.5)	Ref
Quartile 2 (15-17)	114(26.9)	16(14.0)	98(86.0)	1.48(0.72,3.05)
Quartile 3 (18-21)	93(21.9)	18(19.4)	75(80.7)	**2.04(1.01,4.10)**
Quartile 4 (More stress) (22-39)	101(23.8)	24(23.8)	77(76.2)	**2.51(1.29,4.86)**
Top quartile (≥22)	101(23.8)	24(23.8)	77(76.2)	**1.71(1.10,2.65)**
Lower 3 quartiles (<22)	323(76.2)	45(13.9)	278(86.1)	Ref
Social support				
Quartile 1 (Low)(13-38)	84(19.6)	24(28.6)	60(71.4)	**2.00(1.17,3.42)**
Quartile 2 (39-47)	123(28.7)	19(15.5)	104(84.6)	1.08(0.60,1.94)
Quartile 3 (48-52)	89(20.8)	9(10.1)	80(89.9)	0.71(0.34,1.49)
Quartile 4 (High) (53-55)	133(31.0)	19(14.3)	114(85.7)	Ref
Top quartile (Quartile 4) (≥53)	133(31.0)	19(14.3)	114(85.7)	Ref
Lower three quartiles (Quartiles 1-3) (<53)	296(69.0)	52(17.6)	244(82.4)	1.23(0.76.1.20)
Racism Lifetime experiences				
Quartile 1 (Fewer experiences) (1-6)	79(18.4)	12(15.2)	67(84.8)	Ref
Quartile 2 (7-9)	101(23.5)	16(15.8)	85(84.2)	1.04(0.52,2.08)
Quartile 3 (10-13)	102((23.8)	16(15.7)	86(84.3)	1.03(0.52,2.06)
Quartile 4 (More experiences) (14-30)	147(34.3)	27(18.4)	120(81.6)	1.21(0.65,2.25)
Top quartile (≥14)	147(34.3)	27(18.4)	120(81.6)	1.18(0.76,1.82)
Lower 3 quartiles (<14)	282(65.7)	44(15.6)	238(84.4)	Ref

Abbreviations: **CI** = confidence interval, **Ref** = reference, **PR** = prevalence ratio
Bolded values indicate estimates with 95% CIs that do not cross the null value

Table 2: Distribution of Psychological demands by Preterm birth, Baltimore Study (N=429), 2001-2004

	Total sample N(%)	Preterm N(%)	No Preterm N(%)
Psychological demands			
Working very fast			
Yes	290(67.8)	50(17.2)	240(82.8)
No	138(32.2)	21(15.2)	117(84.9)
Long periods of intense concentration			
Yes	260(60.8)	46(17.7)	214(82.3)
No	168(39.3)	25(14.9)	143(85.1)
Conflicting demands			
Yes	216(50.2)	38(17.6)	178(82.4)
No	213(49.8)	33(15.5)	180(84.5)
Very hectic			
Yes	249(58.5)	38(15.3)	211(84.7)
No	177(41.5)	33(18.6)	144(81.4)
Working very hard			
Yes	350(82.0)	57(16.3)	293(83.7)
No	77(18.0)	14(18.2)	63(81.8)
Tasks often interrupted before completion			
Yes	230(53.9)	36(15.6)	194(84.4)
No	197(46.1)	35(17.8)	162(82.2)
Asked to do an excessive amount of work			
Yes	240(50.1)	46(19.2)	194(80.8)
No	188((43.9)	25(13.3)	163(86.7)
Not enough time to get the job done			
Yes	62(14.5)	14(22.6)	48(77.4)
No	366(85.5)	57(15.6)	309(84.4)
Psychological demands construct			
Median split			
High	189(44.2)	37(19.6)	152(80.4)
Low	239(55.8)	34(14.2)	205(85.8)
Quartiles			
Quartile 1 (Lowest demands) (8-18)	84(19.6)	14(16.7)	70(83.3)
Quartile 2 (19-21)	155(36.2)	20(12.9)	135(87.1)
Quartile 3 (22-23)	101(23.6)	15(14.9)	86(85.1)
Quartile 4 (Highest demands) (24-32)	88(20.6)	22(25.0)	66(75.0)
Top quartile (Quartile 4)	88(20.6)	22(25.0)	66(75.0)
Lower 3 quartiles (Quartiles 1-3)	340(79.4)	49(14.4)	291(85.6)

Table 3: Univariate and multivariable analyses of psychological demands and the risk of Preterm birth (N=429)

	Unadjusted PR (95% CI)	**Adjusted* Model aPR (95% CI)**
Psychological Demands		
Working very fast		
Yes vs No	1.13 (0.71,1.81)	1.13 (0.71,1.79)
Long periods of intense concentration		
Yes vs No	1.19 (0.76,1.86)	1.23 (0.79,1.93)
Conflicting demands		
Yes vs No	1.02 (0.67,1.56)	1.17 (0.77,1.77)
Very hectic		
Yes vs No	0.82 (0.54,1.25)	0.80 (0.53,1.20)
Working very hard		
Yes vs No	0.90 (0.53,1.52)	0.91 (0.55,1.51)
Tasks often interrupted before completion		
Yes vs No	0.88 (0.58,1.35)	0.79 (0.53,1.19)
Asked to do an excessive amount of work		
Yes vs No	1.44 (0.92,2.26)	1.32 (0.84,2.07)
Not enough time to get the job done		
Yes vs No	1.45 (0.86,2.44)	1.49 (0.92,2.42)
Psychological demands construct		
Median split		
High vs Low psychological demands	1.38 (0.90,2.10)	1.36 (0.90,2.06)
Quartiles		
1 (Lowest demands)	ref	
2	0.77 (0.41,1.45)	0.77 (0.41,1.44)
3	0.89 (0.46,1.74)	0.87 (0.46,1.65)
4 (Highest demands)	1.50 (0.82,2.73)	1.55 (0.86,2.79)
Top quartile vs Lower 3 quartiles	**1.73 (1.11,2.71)**	**1.82 (1.20,2.76)**

*Adjusted for Marital status/Cohabitation, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

PR: Prevalence Ratio **aPR:** Adjusted Prevalence Ratio **CI**: Confidence Interval **Ref:** Reference

Figure 1: Psychological demand composite-related differences in risk of preterm birth within strata of social support and depression

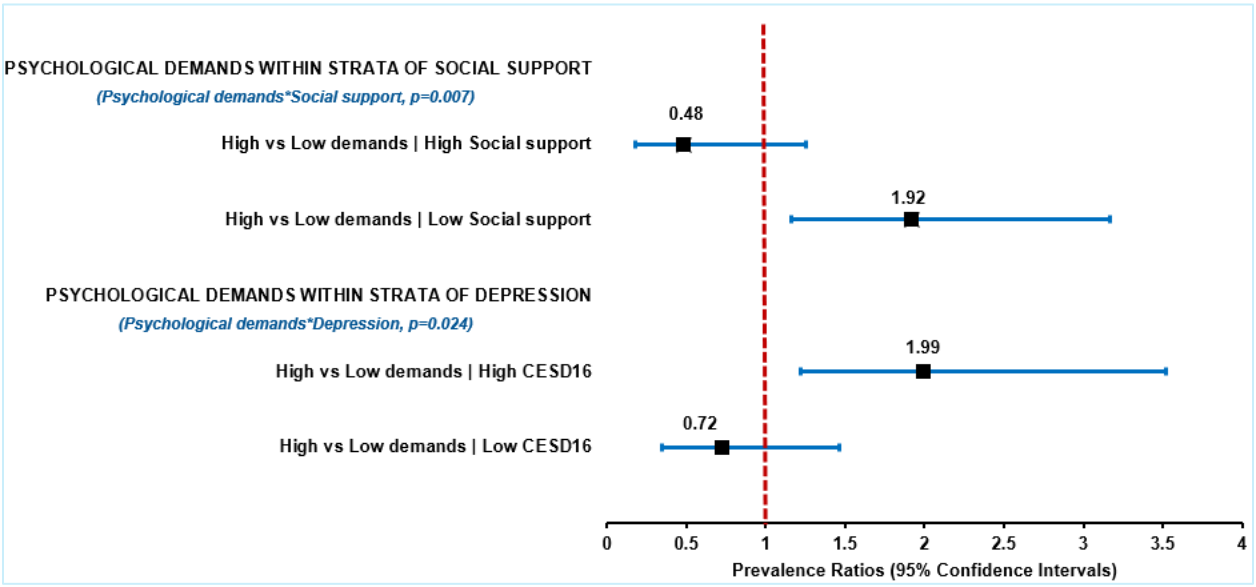


Figure 2: Working hard and intense concentration-related differences in risk of preterm birth within strata of social support

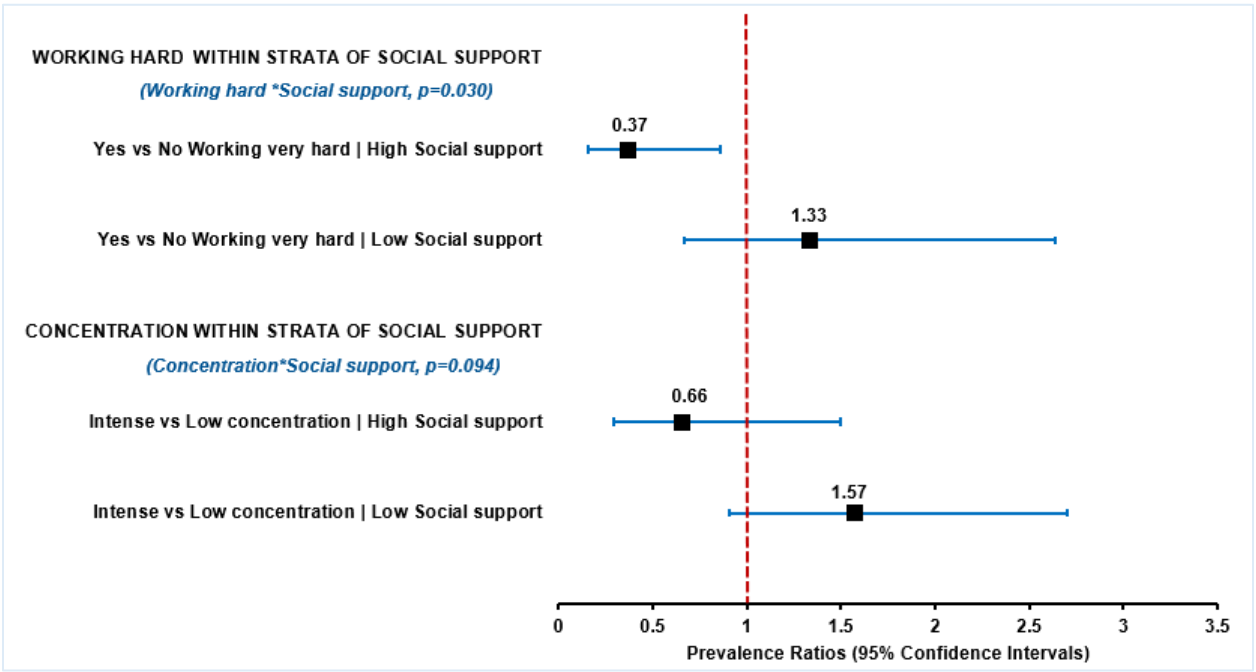
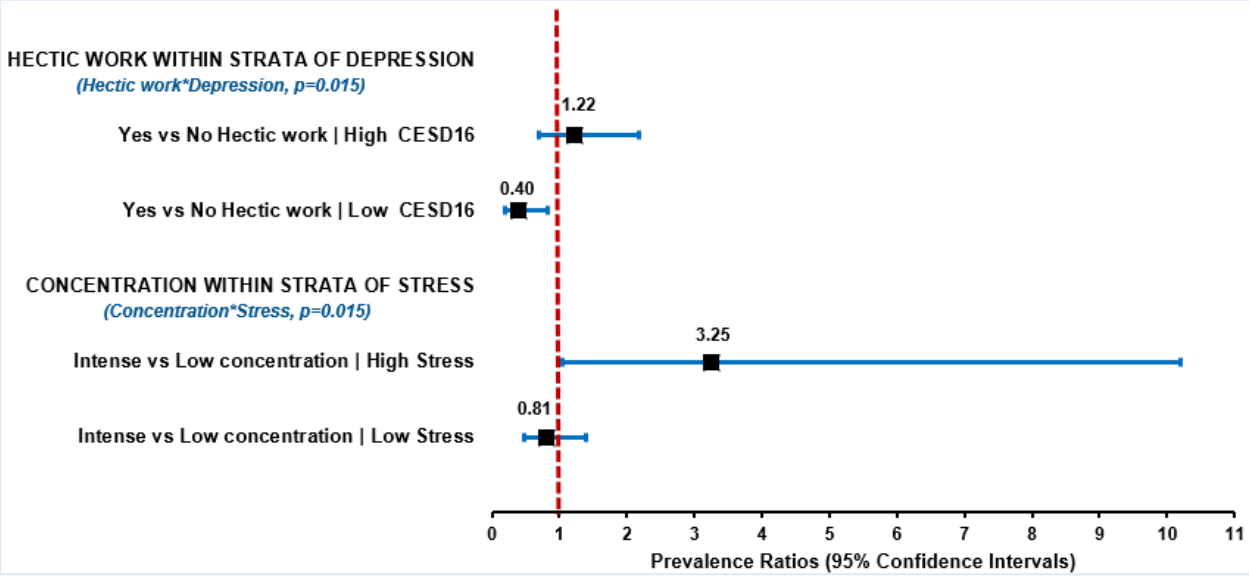


Figure 3: Hectic work and intense concentration-related differences in risk of preterm birth within strata of depression and stress



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APPENDIX B

Supplementary Tables (S1-S4)

Psychological demands-related differences in risk of preterm birth varied within strata of psychosocial factors

Table S1: Psychological demands of work and social support

Model terms	Stratum	Work factor aPR (95% CI)	Interaction *P*-value
Intense concentration*social support	High social support	0.66(0.29,1.50)	***P* = 0.094**
	Low social support	1.57(0.91,2.70)	
Working hard*social support	High social support	**0.37(0.16,0.86)**	***P* = 0.030**
	Low social support	1.33(0.67,2.64)	
Excessive work *social support	High social support	0.81(0.36,1.86)	*P* = 0.179
	Low social support	1.61(0.93,2.79)	
Hectic work*social support	High social support	0.57(0.25,1.30)	*P* = 0.361
	Low social support	0.89(0.55,1.46)	
Interrupted tasks*social support	High social support	0.68(0.30,1.54)	*P* = 0.660
	Low social support	0.84(0.51,1.38)	
Not enough time*social support	High social support	0.80(0.20,3.21)	*P* = 0.271
	Low social support	1.72(0.98,3.03)	
Conflicting demands*social support	High social support	0.78(0.33,1.86)	*P* = 0.281
	Low social support	1.34(0.80,2.24)	
Working fast*social support	High social support	1.25(0.48,3.26)	*P* = 0.807
	Low social support	1.09(0.64,1.86)	
Psychological demands construct median*social support	High social support	0.48(0.18,1.25)	***P* = 0.007**
	Low social support	**1.92(1.16,3.17)**	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S2: Psychological demands of work and depression

Model terms	Stratum	Work factor aPR (95% CI)	Interaction *P*-value
Intense concentration*depression	High depression	1.70(0.89,3.24)	*P* = 0.111
	Low depression	0.81(0.41,1.57)	
Working hard*depression	High depression	1.08(0.53,2.18)	*P* = 0.450
	Low depression	0.72(0.33,1.57)	
Excessive work *depression	High depression	1.63(0.88,3.05)	*P* = 0.260
	Low depression	0.97(0.50,1.90)	
Hectic work*depression	High depression	1.22(0.69,2.18)	***P* = 0.015**
	Low depression	**0.40(0.20,0.82)**	
Interrupted tasks*depression	High depression	1.03(0.60,1.78)	*P* = 0.152
	Low depression	0.55(0.28,1.09)	
Not enough time*depression	High depression	1.97(1.09,3.55)	*P* = 0.105
	Low depression	0.73(0.23,2.31)	
Conflicting demands*depression	High depression	1.49(0.84,2.65)	*P* = 0.154
	Low depression	0.79(0.39,1.57)	
Working fast*depression	High depression	0.99(0.55,1.80)	*P* = 0.767
	Low depression	1.14(0.56,2.34)	
Psychological demands construct median*depression	High depression	**1.99(1.12,3.52)**	***P* = 0.024**
	Low depression	0.72(0.35,1.46)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S3: Psychological demands of work and stress

Model terms	Stratum	Work factor aPR (95% CI)	Interaction *P*-value
Intense concentration*stress	High stress	**3.25(1.04,10.20)**	***P* = 0.015**
	Low stress	0.81(0.47,1.39)	
Working hard*stress	High stress	1.13(0.44,2.88)	*P* = 0.513
	Low stress	0.77(0.41,1.48)	
Excessive work *stress	High stress	0.94(0.46,1.91)	*P* = 0.238
	Low stress	1.64(0.91,2.95)	
Hectic work*stress	High stress	0.77(0.38,1.58)	*P* = 0.938
	Low stress	0.74(0.43,1.28)	
Interrupted tasks*stress	High stress	0.88(0.43,1.80)	*P* = 0.605
	Low stress	0.69(0.40,1.20)	
Not enough time*stress	High stress	1.49(0.61,3.61)	*P* = 0.882
	Low stress	1.36(0.66,2.80)	
Conflicting demands*stress	High stress	1.89(0.87,4.11)	*P* = 0.125
	Low stress	0.92(0.53,1.59)	
Working fast*stress	High stress	1.84(0.76,4.45)	*P* = 0.118
	Low stress	0.82(0.46,1.45)	
Psychological demands construct median*stress	High stress	1.95(0.92,4.14)	*P* = 0.163
	Low stress	1.02(0.59,1.76)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Table S4: Psychological demands of work and racism

Model terms	Stratum	Work factor aPR (95% CI)	Interaction *P*-value
Intense concentration*racism	High racism	1.16(0.56,2.40)	*P* = 0.829
	Low racism	1.28(0.72,2.26)	
Working hard*racism	High racism	0.86(0.40,1.84)	*P* = 0.764
	Low racism	1.01(0.49,2.09)	
Excessive work *racism	High racism	0.89(0.44,1.78)	*P* = 0.139
	Low racism	1.79(0.96,3.33)	
Hectic work*racism	High racism	0.59(0.30,1.17)	*P* = 0.312
	Low racism	0.93(0.54,1.58)	
Interrupted tasks*racism	High racism	0.75(0.38,1.51)	*P* = 0.992
	Low racism	0.76(0.44,1.30)	
Not enough time*racism	High racism	1.22(0.51,2.93)	*P* = 0.590
	Low racism	1.66(0.84,3.29)	
Conflicting demands*racism	High racism	0.78,0.38,1.59)	*P* = 0.156
	Low racism	1.46(0.85,2.52)	
Working fast*racism	High racism	1.17(0.54,2.52)	*P* = 0.914
	Low racism	1.11(0.62,1.96)	
Psychological demands construct median*racism	High racism	0.95(0.47,1.94)	*P* = 0.206
	Low racism	1.69(0.98,2.91)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

Abbreviations: **aPR**: Adjusted Prevalence Ratio **CI**: Confidence Interval

Figure S1. Power analysis curve

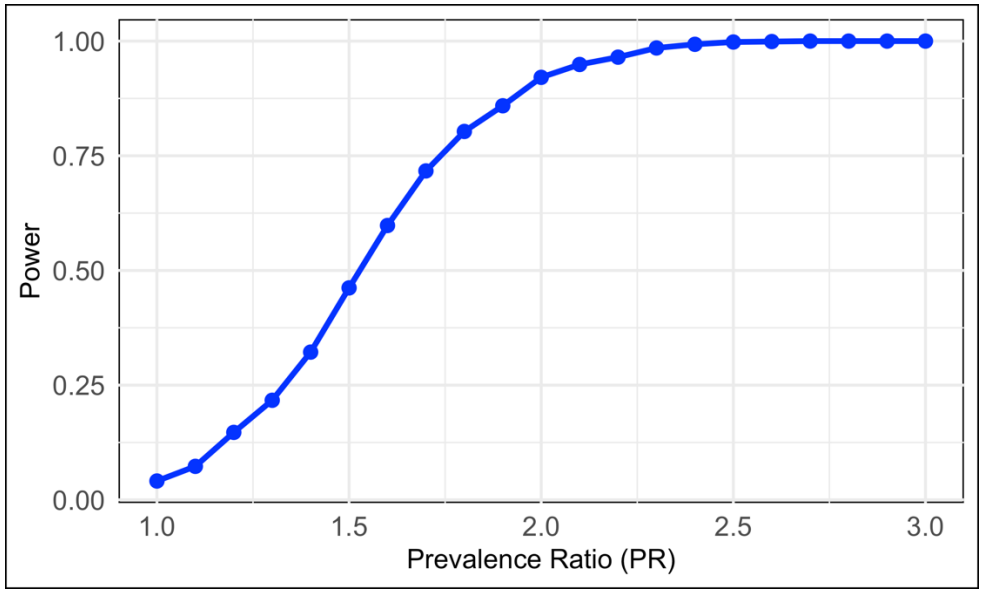

Figure S1 shows the power analysis curve for long-binomial regression for sample size of 429 and prevalence of preterm birth of 16.6%. The blue curve represents the statistical power corresponding to different Prevalence Ratios (PRs). We conducted a simulation-based power analysis to determine the statistical power for detecting the association between psychological job demands and preterm birth (PTB) (**Figure S1**). Given the study's sample size (N=429) and the estimated prevalence of PTB (16.6%), we simulated binary exposure and outcome data under different Prevalence Ratios (PRs) ranging from 1 to 3. For each PR value, we generated 1000 datasets and fitted log-binomial regression models. We then extracted the p-value for the exposure effect and calculated the proportion of simulations where the association was statistically significant at a significance level $\alpha = 0.05$. The power analysis indicates that with a sample size of 429 and a PTB prevalence of 16.6%, the study is adequately powered (80% power) to detect a minimum PR of 1.80.

CHAPTER 6: JOB STRAIN AND RISK OF PRETERM BIRTH AMONG BLACK WOMEN (MANUSCRIPT 3)

Abstract

Background: Preterm birth (PTB) accounts for most neonatal mortality, morbidity, and long-term neurological disabilities. PTB disproportionately affects Black women in the United States and is the leading cause of infant mortality among Black infants. How the psychosocial job strain in the work environment relates to the risk of PTB is a less studied area, especially among Black women. Our study aimed to investigate the role of job strain in the work environment on PTB risk among Black mothers and to identify psychosocial factors that may moderate the association.

Methods: We used data from a cohort study of Black women residing in Baltimore (2001-2004). Our study focused on the 429 employed during pregnancy. Job strain was assessed using Karasek's Job Demands and Control questionnaire items pertaining to psychological demands and women's level of control in the work environment. Women's scores on job demands and control questionnaire were dichotomized at the median score and combined into four exposure categories: low strain (low demands and high control), active (high demands and high control), passive (low demands and low control), and high strain (high demands and low control). Tertile distributions were also created for three level job strain exposure categories (high, intermediate, and low strain). We used log-binomial regression analyses to determine the role of job strain on PTB risk and to adjust for the potential covariates. On a multiplicative scale, we explored potential moderators (depressive symptoms, social support, stress, and lifetime experiences of racism), and a p-value of less than 0.10 was used for the

statistical significance of the interaction term. Results are presented as prevalence ratios (PR) and 95% Confidence Intervals (95% CI).

Results: Among the 429 employed women, 71(16.6%) experienced PTB. We observed non-significant increased PTB rates among women with high strain (aPR=1.47; 95% CI:0.80,2.72) and active jobs (aPR=1.42; 95% CI:0.76,2.66) compared to women who had low strain jobs. Social support (*job strain*social support p=0.03*) moderated the relationship between job strain and PTB. Compared to the low strain jobs, having an active job was associated with more than double increase in PTB among women with low social support (aPR: 2.47; 95% CI:1.12,5.44). Further, having a high strain job was associated with double the increase of PTB (aPR: 2.05; 95% CI:0.93,4.53) among women with low social support. Depressive symptoms (*job strain*depressive symptoms p= 0.03*) moderated the relationship between job strain and PTB. Compared to low strain jobs, having an active job (aPR: 3.10; 95% CI:1.07,8.98) and a high strain job (aPR: 3.59; 95% CI:1.28,10.05) were significantly associated with a 3 times increase in PTB among women with high depressive symptoms. Further, having a passive job was associated with increased PTB rates (aPR: 2.32; 95% CI:0.78,6.89) among women with high depressive symptoms, though the confidence interval included the null value of 1.

Conclusion: Black women with active and high strain jobs have elevated PTB rates after considering psychosocial factors. Intervention efforts should focus on addressing exposure to job strain and these psychosocial factors. The findings highlight the need for implementing policies that will accommodate pregnant women in such spaces with the end goal of improving pregnancy outcomes.

PTB: Preterm birth; **aPR**: Adjusted prevalence ratio **CI**: Confidence intervals

6.1 Introduction

Preterm birth (PTB) contributes to most neonatal mortality, morbidity, and long-term neurological disabilities.[1] Globally, about 15 million babies are born prematurely every year[2] and in the United States (US), PTB affects 1 in every 10 infants born.[3] PTB disproportionately affects Black women in the US and is the leading cause of infant mortality among Black infants.[3,4] Survivors may have complications like cerebral palsy, developmental delays, vision, hearing problems, and cardiovascular disease during adulthood.[3,5–7] Various risk factors such as smoking, education, and socioeconomic status are associated with PTB, but do not fully explain the high PTB rates among Black women, hence the need to explore other contributors.

Women have been part of the workforce for decades,[8–10] and the proportion working has increased over time.[11–13] Women continue working while pregnant for personal benefits and economic necessity. However, pregnant women may also experience job strain in the workplace, a form of psychosocial stress that jointly considers workload demands with a lack of independence in their tasks, not being part of decision-making, and discrimination that may happen in such spaces.[14] Most studies that have examined job strain and PTB risk have utilized the Karasek job demand-control model.[15] This model consists of two dimensions: job demands (psychological demands) and job control (decision latitude). Job demand is the extent of the psychological workload, task requirements, and the amount of time allocated to accomplish tasks. High job demands may include tight deadlines, high work pressure, and complex tasks.[16,17]Job control consists of skill discretion (ability to utilize specific skills during task completion and the competence to learn new skills) and decision

authority (autonomy one has over the tasks to be completed, timing, and how to accomplish the tasks).[16,18] The Karasek model assumes that psychological stress results from the joint effects of work demands and the flexibility an individual has to make decisions in a workplace.[19] Most studies that have examined the effect of job strain on preterm birth have utilized the median score approach to create four categories of job strain: low strain jobs (low demands and high control), passive jobs (low demands and low control), active (high demands and control) and high strain (high job demands with low control). Low-strain jobs include low-demanding duties, and employees can choose their schedule. Teachers, hairdressers, and engineers have been categorized as having relaxed or low strain jobs.[20] High strain jobs are usually very demanding, and the employee has limited control. Such jobs usually lead to high stress. Nursing aides, cleaners, dental assistants, telephone operators, waitresses, and sewing machine operators have been reported to have high strain jobs.[20] Passive jobs are simple duties without a decision measure and have the minimum risk of stress. Women working as clerical workers, bank assistants, and laboratory workers have been categorized as having passive jobs.[20] Active jobs are very tasking but allow employees to decide their schedules. As a result, they are not perceived as stressful jobs but opportunities for new challenges that foster progress.[21] Nurses and journalists have been reported as having active jobs.[20]

Outside of pregnancy, job strain impacts physical and psychological health and increases the risk of chronic hypertension and coronary heart disease.[22,23] Among pregnant women, only a small number of studies have examined the effect of job strain on PTB.[20,24–31] Of these studies, only three were conducted in the US[25,26,29] and of

those, Brett et al.[29] evaluated the impact of job strain on PTB among Black women,[29] with the other two studies controlled for race as a confounder.[25,26] The findings from these studies have been inconclusive, with some reporting elevated risk of PTB with job strain[25,26,29,30] and others reporting no association.[24,31]

We analyzed data from a large Black-only cohort, which included measurement of unique exposures such as experiences of racism that are distinctive to this population. Stress, depressive symptoms, lack of social support, and racism are reported to be associated with PTB and may interact with the psychosocial job strain that women experience in the workplace. Few studies have examined the moderation of job strain and PTB by social support at work [20,30] or by race.[29] Psychosocial factors and racism are central to Black women and have been reported to be important moderators of other risk factors in previous studies of birth outcomes.[32–34]

Our study objectives were to 1) evaluate the association between job strain and PTB and 2) determine whether depressive symptoms, social support, perceived stress, and lifetime experiences of racism modify the association between job strain and PTB. Understanding these relationships is critical for developing targeted interventions to reduce PTB rates and address systemic inequities affecting Black women.

6.2 Methods

6.2.1 Design, Data, and Study Population

Details of the Baltimore study have been previously published[33]. Briefly, the Baltimore study is a cohort study of Black women in Baltimore, Maryland, USA. Women were enrolled into the study based on 1) self-identifying as Black; 2) residing in Baltimore; 3) having received prenatal care at one of the three Johns Hopkins Medical Institution

(JHMI) prenatal clinics (prospective) or having birthed their babies at the JHMI hospital (retrospective).[33] During the recruitment period (2001-2004), 872 women were enrolled prenatally (N=484) or postpartum (before discharge) (N = 388) with a response rate of 68%. Interviews were conducted twice for prenatally enrolled women: 22-28 weeks gestation and postpartum hospitalization. Interviews were done only at enrollment for women enrolled via postpartum.[33] During these in-person interviews, information on socio-demographics, psychosocial factors, and health behaviors was obtained. Trained research staff abstracted data for gestation age, presence of chronic diseases, and any pregnancy complications from medical records. After excluding multiple births (n = 24) and losses to follow-up (n = 16), 832 participants had data on singleton births. For this study, we focused on the 429 women employed during pregnancy as the analytic sample.

Ethical approval

The Baltimore cohort study was evaluated and authorized by institutional review boards at the relevant institutions.[33]

6.2.2 Measures

Outcome: Preterm Birth (PTB)

The primary outcome, PTB, was defined as birth before 37 completed weeks of gestation.[35] Measures of gestational age at delivery (including early ultrasound and last menstrual period) were abstracted from the medical record with a hierarchical algorithm that prioritized early ultrasound followed by the mother's reported LMP date, followed by late ultrasound, and then the clinician estimates if nothing else was available to determine the most accurate gestational age at delivery.[36]

Exposure: Job Strain

Job strain was measured using the women's responses to Karasek's Job Demand and Control (JDC)[15] questionnaire. We considered women's responses to JDC items pertaining to psychological demands (e.g., hectic jobs, long periods of intense concentration, working very fast, working very hard) and job control (e.g., skill level, learning new things, repetitive work, creativity, freedom on how to work, make decisions, develop own special abilities, and do a variety of things). Each item consists of a statement with the respondent indicating their level of agreement on a scale from 1 (strongly disagree) to 4 (strongly agree). Women's psychological demands and job control scores were formulated into two summary scores – job demand (median = 21, range = 24) and job control (median = 26, range = 25). The median value on demand and control was used to determine the high and low categories.[37] We created four groups of job strain from the combination of the median-split categories: low strain jobs (low demands and high control), active jobs (high demands and high control), passive jobs (low demands and low control), and high strain jobs (high demands and low control).[16,26,38] Those in the low strain jobs category were the referent group because they experienced the most ideal job scenario: low demands with high control. Further, we considered the tertile-based job strain by dividing distributions of job demands and control into tertiles. Prior studies have utilized tertile based formulations to evaluate the role of job strain on health outcomes[20,29,37,39–41] but only two studies[20,29] have utilized tertile-based job strain in addition to median-based job strain to examine the role of job strain on PTB. Tertile-based job strain may mitigate misclassification bias from assigning more individuals to the active job category than have a job strain classified as

active that may arise from relying on only median-based job strain exposure cut points. Further, tertile-based measures may be helpful in the comparison of PTB among women with more extreme scores on the median measures.[20] The high strain category was composed of the highest two tertiles in demands combined with the lowest two tertiles in control. The low strain category was formed by the lowest two tertiles in demands combined with the highest two tertiles in control, and the intermediate category contained all the rest of the combinations[39,40] (Figure 1). We also examine individual associations of job demand and job control with PTB as continuous variables to further address exposure misclassification that may arise from assigning women to the job strain categories.[42]

Figure 1: Distribution of tertile-based job strain levels

Control	Psychological Demands		
	Low	Intermediate	High
Low	Intermediate	High strain	High strain
Intermediate	Low strain	Intermediate	High strain
High	Low strain	Low strain	Intermediate

Covariates: We evaluated maternal characteristics (maternal education, age, marital/cohabiting, adequacy of resources, behavior, and parity) as potential confounders. Covariates were considered potential confounders if identified as confounders in the literature on workplace exposures and/or PTB.[43–48]

In-person interviews were used to obtain information on age and marital status. Age was measured as a continuous variable, and we created 4 age groups (≤19; 20-24, 25-29, 30+) for the analysis. Women were asked if they were married, cohabiting, or single. We combined the married and cohabiting groups for our study and used the single group as our reference. Education was measured as a continuous variable

indicating the highest grade/year of school completed. For our study, we created 3 groups: Less than high school, high school diploma / GED and beyond high school and used less than high school as our reference. Smoking was measured using a brief set of standard questions to determine lifetime exposure and exposure to smoking by trimester (yes/no, amount) and cessation. Adequacy of family resources in terms of time and money[49,50] was measured using the Family Resources Scale[49] (FRS), a 25-item instrument. Women reported on how often they had specific resources (e.g., “enough money to buy food for two meals a day while pregnant,” “enough money to pay monthly bills.”) Responses were measured using a Likert scale ranging from 1 (almost always) to 5 (almost never) with lower values indicating greater family resources. Items were summed to create a continuous variable, and quartiles were constructed for analysis. Parity (≥1 previous live births vs. no previous live births) was obtained using the medical history abstraction instrument and confirmed with the maternal interview.

Moderators: We *a priori* conceptualized four factors as potential moderators of the workplace exposure-PTB associations: depressive symptoms, stress, social support, and lifetime experiences of racism. We considered these factors because they are important for Black women’s lives, and there is variation within the analytic sample, and they are important predictors of PTB.

Depressive symptoms

Depressive symptoms were measured using the 20-item Center for Epidemiologic Studies Depressive Scale (CES-D),[51,52] which has a Cronbach α of 0.89.[33] Participants were asked to think about how often they had experienced symptoms in the past week. Items were scored from 0 (rarely/never) to 3 (most of the time). Items were summed to

generate a continuous variable, which was then dichotomized for analysis. We considered the ≥16 cut, which has been used to indicate a likely diagnosis of depressive symptoms[33] and found to be associated with PTB.[53,54]

Stress

Stress was measured using a 12-item Prenatal Psychosocial Profile Hassles Scale[55,56] with a Cronbach's α of 0.81.[49] Respondents were asked to indicate to what extent things that occurred during pregnancy made them stressed. Examples include "worries about food, shelter, health care, and transportation,' 'money worries like paying bills,' 'problems related to family,' 'having to move,' either recently or in the future,' 'a recent loss of a loved one sexual,' 'emotional or physical abuse' etc. Responses for each item range from 1 (no stress) to 4 (severe). Items were summed to create a continuous variable with lower values correlating to no/less stress. Quartiles were used to construct a 4-level categorical variable for analysis.

Social support

A shortened version of the Medical Outcomes Study Social Support Survey[57] was used to measure social support. This scale has 11 items and a Cronbach's alpha of 0.90. We considered the dimensions of social and emotional support as global measures and were not specific to being within or outside the workplace. Respondents were asked how often specific kinds of support were available to them when they needed it. Examples include "someone you can count on to listen when you need to talk,' 'someone to help with daily chores if you were sick,' 'someone to take you to the doctor if you needed it,' and 'someone to love and make you feel wanted." Responses ranged from 1 (none of the time) to 4 (most of the time), with lower values corresponding to less

social support. Items were summed to create a single, continuous variable, with lower values correlating to no/less social support. Quartiles were used to construct a categorical variable for analysis.

Racism life experiences

We used the Racism and Life Experiences Scale-Brief Version (RaLES-BRF) by Harrell[58–60] to measure lifetime experiences of racism. It is a 9-item scale with Likert responses that assess broad lifetime exposure to racism (e.g., In general, how frequently do you hear about incidents of racial prejudice, discrimination, or racism from family, friends, co-workers, neighbors, etc.). The scale's psychometric properties have demonstrated high reliability and strong validity.[61] Items were summed to create a continuous variable and quartiles were used to construct a categorical variable for analysis.

6.2.3 Statistical analysis

Descriptive characteristics of the study population were summarized using frequencies and percentages. Using the chi-square test, we compared the distribution of maternal characteristics by job strain categories. We estimated prevalence ratios (PR) and their corresponding 95% confidence intervals (95% CI) using bivariate and multivariable log-binomial regression models.[62,63] We used log-binomial instead of logistic regression since the PTB rate in the cohort (16.6%) indicated a common outcome.[64] We used a p-value of <0.25 [65] for the unadjusted associations as suggestive of a potential role as a confounder. In multivariable analyses, we used a forward stepwise approach, beginning with crude models (i.e., unadjusted), followed by models adjusting for sociodemographic, behavioral factors, parity, and adequacy of family resources. We

explored moderation on a multiplicative scale by adding an interaction term between the exposure and the potential moderator to the adjusted regression models. We compared the likelihood ratios (LRs) to determine whether the model with interactions provided a better fit to the data than the model without them. We determined the significance of the interaction terms using the Likelihood Ratio (LR) chi-square test and if the associated p-value was less than 0.10. All analyses were conducted using SAS software, version 9.4 (SAS Institute, Cary, NC).

6.3 Results

The mean age for the participants was 24.0 years. Of the 429 working women, 16.6% had a PTB, 41% had depressive symptoms, 50% were married or cohabiting, and 66% of the women had attained a high school diploma/GED or training beyond high school (Table 1). Several covariates were associated with PTB: smoking during the second trimester; unmet needs (less resources) in terms of money and time; high stress; high depressive symptoms, and low social support (Table 1). Table 2 shows the distribution of maternal characteristics by the four categories of job strain. We observed significant differences across job strain categories for education, smoking, social support, and the adequacy of family money resources (Table 2).

Compared to women with low strain jobs we observed modest, albeit nonsignificant, associations with PTB for women with high strain jobs (aPR=1.47; 95% CI:0.80,2.72) and active jobs (aPR=1.42; 95% CI:0.76,2.66) (Table 3). There was no association with PTB for women with passive jobs (aPR=1.12; 95% CI:0.61,2.09), compared to low strain jobs (Table 3).

Further analysis using the tertile-based job strain categories showed a modest non-significant PTB for women with intermediate job strain jobs (aPR=1.36; 95% CI: 0.81,2.27) compared to those with low strain jobs. There was no association for women with high strain jobs (aPR=1.00; 95% CI: 0.56,17.9) compared to those with low strain jobs. We did not observe any significant associations when we examined the role of job demand (aPR=1.04; 95% CI: 0.98,1.12) and job control (aPR=0.98; 95% CI:0.93,1.04) as continuous exposures (Table S1).

Moderation

Median score job strain categories

Social support significantly moderated the relationship between job strain and PTB (*job strain*social support p= 0.030*). Among women with low social support, compared to women with low strain jobs, having an active job was significantly associated with increased PTB rates (aPR: 2.47; 95% CI:1.12,5.44). Having a high strain job was associated with increased PTB rates (aPR: 2.05; 95% CI:0.93,4.53), while having a passive job had a modest association with PTB (aPR: 1.31; 95% CI:0.57,3.03), but the confidence interval included the null value of 1 for both PRs. Among women with high social support, having an active job (aPR: 0.33; 95% CI:0.08,1.44) and having a high strain job (aPR: 0.77; 95% CI:0.22,2.64) were associated with lower non-statistically significant PTB rates. There was no association between passive jobs and PTB (Figure 2, Table S2).

Depressive symptoms moderated the relationship between job strain and PTB (*job strain*depressive symptoms p = 0.028).* Among women with high depressive symptoms, having an active job (aPR: 3.10; 95% CI:1.07,8.98) and a high strain job

(aPR: 3.59; 95% CI:1.28,10.05) were significantly associated with increased PTB, compared to women with low strain jobs. Further, having a passive job was associated with increased PTB (aPR: 2.32; 95% CI:0.78,6.89), but the confidence interval included the null value of 1. Among women with low depressive symptoms, having an active job (aPR: 0.76; 95% CI:0.32,1.85), a high strain job (aPR: 0.42; 95% CI:0.13,1.42), and a passive job (aPR: 0.74; 95% CI:0.32,1.70) were associated with lower PTB but the confidence intervals included the null value of 1 (Figure 3, Table S2).

Neither stress nor experiences of racism significantly moderated the relationship between job strain and PTB (Table S2).

Tertile-based job strain categories

Depressive symptoms moderated the relationship between job strain and PTB (*job strain*depressive symptoms p = 0.063*). Among women with high depressive symptoms, having a high strain job (aPR: 1.97; 95% CI: 0.78, 4.97) and an intermediate strain job (aPR: 2.12; 95% CI: 0.86, 5.19) were associated with increased PTB, compared to women with low strain jobs. However, the confidence intervals included the null value of 1. Among women with low depressive symptoms, having a high strain job (aPR: 0.43; 95% CI:0.16, 1.14) and an intermediate strain job (aPR: 0.91; 95% CI:0.45,1.89) were associated with lower PTB but the confidence intervals included the null value of 1 (Figure 4, Table S3).

Stress moderated the relationship between job strain and PTB (*job strain*stress p = 0.073*). Among women with high stress, having a high strain job (aPR: 1.75; 95% CI: 0.63,4.83) and an intermediate strain job (aPR: 1.26; 95% CI: 0.43,3.70) were associated with increased PTB, compared to women with low strain jobs. However, the

confidence intervals included the null value of 1. Among women with low stress, having a high strain job (aPR: 0.59; 95% CI: 0.26,1.34) was associated with lower PTB compared to low strain jobs. Compared to low strain jobs, having an intermediate strain job (aPR: 1.38; 95% CI:0.76,2.53) was associated with a modest increase in PTB but the confidence intervals included the null value of 1 (Figure 5, Table S3).

Neither social support nor experiences of racism significantly moderated the relationship between job strain and PTB (Table S3).

6.4 Discussion

How job strain impacts the risk of PTB has not been studied extensively, especially among Black women in the U.S.[3] In a recent meta-analysis, Adane et al.[66] identified nine studies that evaluated the impact of job strain on PTB, and only three of these studies were conducted in the U.S. Most of these studies, except Meyer et al.,[26] utilized data collected between the period of 1983 and 1999. Furthermore, only Brett et al.,[29] in a 1997 case-control study, considered evaluating the role of job strain on PTB risk among Black women, the group at the highest risk for PTB.[3] In our study, we aimed to evaluate the effect of job strain on the risk of PTB and to determine whether the association was moderated by psychosocial factors (depressive symptoms, stress, social support) and lifetime experiences of racism among Black women. Our study's findings show that women with high strain and active jobs were at elevated risk of PTB compared to those with low strain jobs. Social support and depressive symptoms each moderated the associations.

6.4.1 Job strain and Preterm birth (PTB)

Median score job strain categories: With low strain jobs as the reference group, our

study found a modest but non-significant increase in PTB risk among women with high strain and active jobs and a weak non-significant association with passive jobs. Our findings highlight the difference in PTB risk among the four job strain categories, which could have been missed if we had only compared high strain to the combination of all the other categories as prior studies.[25,29] Our findings are comparable to Henriksen et al.[20], in a 1994 Denmark study who reported modest, nonsignificant associations with passive jobs (aOR=1.40; 95% CI: 0.80,2.30), high strain jobs (aOR=1.30; 95% CI: 0.70,2.20), and active jobs (aOR=1.20; 95% CI: 0.70,2.20). Our findings are also consistent with Brett et al. in a US study[29]; stratified by race, the PTB odds were higher for high job strain compared to low job strain among Black women (aOR=1.50; 95% CI: 0.90, 2.30), but the association was not statistically significant. However, the Brett et al. study only included two categories: high strain (high demand/low control) versus low strain (all other combinations), but our study considered four categories (high strain, active, passive, and low strain) and used the low strain as the comparison group. The subgroup of Black women in Brett et al was similar in size to our sample of employed Black women but was designed as case-control with many more PTB cases than our cohort (191 vs. 71). On the other hand, compared to low strain jobs, Meyer et al.[26] reported a weak association between high strain job and PTB (aOR =1.17; 95% CI: 1.00,1.36). While Brandt et al.,[27] Larsen et al.[31] and Vrijkotte et al.[28] reported no association between job strain and PTB. We did not consider the length of exposure to work strain in pregnancy. Focusing on the subsample of Black cases and controls and constraining the exposure to occurring 30 or more weeks during pregnancy, Brett et al.[29] identified a significantly higher PTB risk (aOR=1.80; 95% CI: 1.10,3.10) associated

with high compared to low strain jobs. The inconsistency of findings from prior studies may be due to the measurement of the exposure and sample size. Two studies, Meyer et al.[26] and Homer et al.,[25] considered job title as a surrogate for exposure measurement. However, using job titles may not consider individual variability and may miss differences by duration of exposure,[29] although this may also be a problem for studies that use the JDC but obtain information at a single time. Most prior studies used self-reported data via telephone or face-to-face interviews or surveys, which may be subject to recall bias.[66] Some studies interviewed women prenatally,[25,28,31] others within 6 weeks after delivery,[24,30] and still others within 12 months after delivery.[27,29] Our study utilized data from a cohort that interviewed women prenatally and immediately postpartum before discharge. Sample sizes of employed women for the previous studies ranged from 398 participants by Brett et al.[29] to 51,265 participants by Larsen et al.[31] Our study size is comparable to that of Brett et al.,[29] in a 1997 study that examined the effect of job strain on PTB and considered stratification by race, but the response rate was slightly higher for the Brett et al. study (73% vs. 68%). Further, Brett et al. used a case-control design with many more cases than our cohort, possibly due to the larger size of their source population that included three North Carolina counties. Our study is the second after Brett et al.,[29] to utilize the JDC[15] questionnaire to assess the effect of job strain on PTB risk among Black women. Our study is also the first to evaluate the psychosocial job strain in a work environment in a cohort of only Black women.

Tertile-based job strain categories: Further analysis using the tertile combinations of job demands and control showed a modest, non-significant PTB association with

intermediate job strain jobs but no association with high strain jobs compared to low strain jobs. Our findings contradict those of Brett et al.[29] that examined the effect of job strain using the median and tertile-based job strain categories and reported a significant association for a subgroup of African American women who had tertile-based high strain jobs compared to those who had low strain jobs (aOR=1.6; 95% CI:1.0, 2.8). Our findings are similar to Henriksen et al.[20] who evaluated a job strain dose response relationship with PTB by median, tertile and quartile levels. The authors reported a weak non-significant PTB association (aOR=1.2: 95% CI:0.6, 2.6) for women who had high strain jobs compared to those who had relaxed jobs for the tertile based job strain. Exposure misclassification may happen when assigning women to job strain categories, leading to biased estimates.[42] However, our study observed similar findings when we examined the role of job demand and job control as continuous exposures on PTB risk, implying a minimal effect of misclassification in our measure of job strain.

6.4.2 Moderation

In contrast to prior publications, our study evaluated the moderating role of psychosocial factors and racism on the association between job strain and PTB based on a multiplicative scale.

Median score job strain categories

Our results suggest that psychosocial factors are important moderators of job strain and the risk of PTB. Social support moderated the relationship between job strain and PTB, such that high strain and active jobs were associated with elevated PTB risk among women with low social support, while high social support buffered the effect of job strain on PTB risk. Three prior studies[20,30,31] conducted stratification analyses to

examine the role of social support in the workplace on the job strain-PTB association. Our findings are consistent with those of Croteau et al.,[30] who reported a modest significant PTB association with high strain combined with low or moderate social support at the beginning of pregnancy (aOR=1.3; 95% CI: 1.0,1.5) compared to low strain. The authors further reported a higher PTB risk when the exposure was not eliminated by preventive measures for the entire period of pregnancy(OR=1.4;95% CI: 1.1,1.8). Findings from our study are also comparable to those of Larsen et al.,[31] who indicated a modest non-statistically significant association (aOR=1.39; CI:0.86, 2.23) for women with high strain jobs and low social support compared to women with low strain jobs. Our findings contradict Henriksen et al.,[20] who reported no difference in PTB-job strain association by social support at work or social support in general. Worth noting is that the prior three studies considered social support specific to the workplace, but our study considered the dimensions of social and emotional support as global measures and were not specific to being within or outside the workplace.

While a small body of work considers social support as a moderator, other moderators we examined have not been reported. Our study also demonstrated that depressive symptoms moderated the relationship between job strain and PTB, such that having active and high strain jobs was significantly associated with increased PTB rates among women with high depressive symptoms. Similarly, having a passive job was associated with high PTB rates among women with high depressive symptoms, but the association was not statistically significant. We found no evidence of moderation of the work strain-PTB associations by perceived stress or racism.

These findings are unique to our study, as prior studies did not consider depressive symptoms, stress, or racism. Our findings suggest that high depressive symptoms and low social support may amplify the effect of job strain on PTB, while low depressive symptoms and high social support may buffer this relationship. It is possible that high social support provides women with resources like positive interactions with social networks at the workplace and outside the workplace, which may alleviate the effect of job strain on PTB. Our findings showed that the joint effect of having high depressive symptoms and being in an active job on PTB was greater than the independent effect of depression on PTB and the independent effect of an active job on PTB. Similarly, the joint effect of having high depressive symptoms and a high strain job was greater than the independent effect of depression on PTB and the independent effect of a high strain job on PTB. Furthermore, the joint effect of having low social support and having an active job was greater than the independent effect of low social support on PTB and the independent effect of having an active job on PTB. These findings suggest a potential synergism between job strain and psychosocial factors (depressive symptoms, social support) on the risk of PTB. It is plausible that the joint exposure may simultaneously stimulate multiple overlapping or complementary biological pathways that synergistically increase the risk of PTB. Our findings suggest that without considering the role of psychosocial factors that women may be experiencing, the effect of job strain on PTB risk may be missed because they are synergistic. Such factors have been explored outside the workplace and found to be associated with PTB[67,68] and also reported to be important moderators.[32–34] Future

studies should consider how psychosocial factors may be interrelated with job strain in the work environment.

Tertile-based job strain categories

Results of moderation analyses differed when we modeled job strain created using tertiles of activity and control. These results suggest that psychosocial factors are important moderators of job strain and the risk of PTB. Depressive symptoms moderated the relationship between job strain and PTB, consistent with what we found for job strain based on median cutpoints. Compared to low strain jobs, high strain and intermediate strain jobs were associated with elevated PTB risk among women with high depressive symptoms, while low depressive symptoms buffered the effect of job strain on PTB risk. In contrast to our models of job strain based on medians, stress moderated the relationship between job strain and PTB. Compared to low strain jobs, high strain and intermediate strain jobs were associated with increased PTB risk among women with high stress, while low stress buffered the effect of high strain jobs on PTB risk but not for intermediate strain jobs. Social support was not a moderator for the models using job strain based on tertiles, unlike what we found for job strain based on medians. Neither the median nor the tertile based models of strain showed any evidence of multiplicative interaction with lifetime experiences of racism.

There was no moderation seen for the job strain-PTB association by racism. Our study had 86% of the women aged ≤ 29 years; it is possible that this may have been a limitation for our study to capture the effects of lifetime experiences of racism, as such experiences may greatly impact older women who have been exposed for a longer period.[69] Further, racism experiences may be important in the workplace context for

PTB, but our specific measure may not have captured them. In our future studies, we will consider evaluating racism experiences specific to the workplace to capture the effect of racism.

Strengths

Our study utilized data collected from a study of a large cohort of low-income Black women, a population disproportionately affected by PTB. Our study is the second, after the Brett et al.[29] 1997 US case-control study, to examine the impact of job strain on PTB among Black women. We utilized robust analytic methods that leveraged the rich contextual data of our study, particularly social and psychosocial measures. Previous studies have not evaluated the moderating role of psychosocial factors when assessing the job strain-PTB association, except the three studies[20,30,31] that considered social support. Our study findings suggest that depressive symptoms (both median and tertile-based job strain), social support (median-based job strain), and perceived stress (tertile-based job strain) are moderators. Another strength of our study is utilizing data from a parent cohort that recruited women prenatally and postpartum. Postpartum recruitment allowed women with late, no prenatal care, and sporadic care to be included, increasing the generalizability of our study findings[70] and reducing potential selection biases.[71–75] Postpartum recruitment would be susceptible to recall bias. However, evidence suggests little recall bias exists for mothers' recall of pregnancy exposures.[76–81] The parent study also provided data on known predictors of PTB and used interviews to obtain data on health behaviors, unlike studies that rely only on birth certificates or medical records alone.[82]

Limitations

Our study utilized cohort study data conducted in the early 2000s. Over the past twenty years, the prevalence of job strain exposure for Black women may have changed but there are no routine data monitoring this. We do know that the PTB rates for Black women have not appreciably improved since the study was completed. Contextual factors like stress and social support may also have changed, but our study's strength was the exploration of these factors through moderation analysis. Secular changes have also occurred over the past twenty years, including the recent passage of the U.S. 2024 Pregnant Fair Workers Act, requiring employers to accommodate pregnant women.[83] This legislation provides an opportunity for data-driven protection. Worth noting is that we do not know whether there was a change in work status during the course of pregnancy, such as women taking sick leave, especially if they have low control at their workplaces. This may have led to an underestimation of the true effect of the exposure on PTB.[20] Further, our study did not explore moderation on an additive scale, a beneficial scale in identifying at-risk groups and prioritizing such groups when implementing interventions.[84] We hope to conduct similar work in future studies that can track any work status changes during pregnancy, address how present-day jobs may affect women’s risk, and also consider a more comprehensive approach that involves evaluating the group-specific differences in outcome prevalence, exposure prevalence, and effect size.[85]

No standard external reference exists to determine the best cut-points to classify job strain into the four categories. Prior studies on the impact of job strain on birth outcomes utilized the median values of job demands and job control measures to

classify workers into the four categories of job strain. However, only one study by Brett et al.,[29] reported the numerical median values (Job demand - 31; Job control - 36) that comprised their cut points, and their medians do not overlap with the ones for our study. With the focus on low-income Black women in our sample, the distributions of job demands and job control likely differ between our cohort and populations included in other studies. This may be due to occupational segregation by race, as there are jobs where Black women are over-represented. Further, our study differs from prior studies as we considered a subset of the working population (low-income Black women) and not the entire working population. Additionally, there were variations in the versions of the job demand control questionnaires used by prior studies, i.e., some used full and others abbreviated versions. Some studies obtained exposure information directly from the mothers,[20,24,27,29,86,87] and others like Meyer et al.,[88] and Homer et al.[25] used job title as a proxy for exposure measurement. Our study utilized the full version of the Karasek job demand and control questionnaire items. As a result, our medians and those of past studies are unlikely to overlap, but we cannot know based on what has been included in publications. The types of jobs that we categorized as active, for example, may reflect very different jobs than those in another study, given the use of sample-specific medians for cut points. The active job strain in our study refers to self-reported responses to the Karasek job demand and control questionnaire items pertaining to their experiences, while other studies utilized the job titles or types as their measure. However, we cannot rule out the misclassification bias associated with how we created the job strain categories, and this may have led to the attenuation or overestimation of the true effect of job strain on PTB, which is a limitation of our study. As a sensitivity

analysis, we also added analyses based on tertile cut points to produce an alternative categorization of job strain, but there was no substantive change in our results.

Additionally, changes in demands or control, hence job strain, could have happened during pregnancy due to modifying duties or taking sick leave, leading to misclassification and underestimating the true effect of job strain on PTB. Additionally, some women could have stopped working in the first trimester. For our study, we included everyone who reported working during pregnancy, implying that for some people, the measure of job strain may not be in an etiologically relevant period for PTB. Furthermore, we used self-reported measures to categorize job strain; these measures may be biased as they are subjective. This bias could be minimized by linking self-reported data to standard occupational data sets. However, using such data sets may also underestimate variability in exposure within the same occupation. A more holistic approach would be to consider both objective (e.g., job descriptions, workload assessments) and subjective (e.g., employee surveys, interviews) measures of workplace strain to capture a comprehensive picture of the work environment.

We did not observe significant differences in the job strain-PTB associations using median or tertile-level job strain categories. Further, we explored individual associations of job demand and job control with preterm birth as continuous variables, since placing the women into job strain categories may lead to misclassification. However, we did not observe differences in estimates, implying that our findings are robust to different exposure specifications.

Significance

Our study is the second to provide evidence on the impact of job strain on PTB risk among Black women, a group disproportionately affected by PTB. The unique

aspect of our study is evaluating the moderation effect of psychosocial factors and racism, contextual factors experienced by Black women. The findings from our study can be instrumental in raising public health awareness of pregnant women on the impact of stresses in the work environment on pregnancy outcomes. Further, evidence can guide workplace policies and accommodations for pregnant women, which would align with the US 2024 Pregnant Fair Workers Act.[83]

6.5 Conclusion

Findings from our study showed that Black women with active and high strain jobs were at elevated risk of PTB when we consider contextual factors. Intervention efforts should focus on addressing exposure to job strain and these factors experienced by women. The findings highlight the need for implementing policies that will accommodate pregnant women in such spaces with the end goal of improving pregnancy outcomes.

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6.6 Tables and Figures

Table 1: Distribution of maternal characteristics: univariate and bivariate distributions with preterm birth, Baltimore Study (N=429), 2001-2004

	Total Sample N(%)	Preterm N(%)	No Preterm N(%)	Crude PR (95% CI)
Maternal factors				
Maternal age (Years)				
≤19	79(18.4)	16(20.3)	63(79.8)	1.54(0.79,3.01)
20-24	190(44.3)	29(15.3)	161(84.7)	1.16(0.63,2.13)
25-29	99(23.1)	13(13.1)	86(86.9)	Ref
30+	61(14.2)	13(21.3)	48(78.7)	1.62(0.81,3.27)
Maternal Education				
Less than high school	144(33.6)	24(16.7)	120(83.3)	Ref
High school diploma /GED	225(52.4)	37(16.4)	188(83.6)	0.99(0.62,1.58)
Beyond high school	60(14.0)	10(16.7)	50(83.3)	1.00(0.51,1.96)
Married/Cohabiting				
Yes	213(49.7)	37(17.4)	176(82.6)	1.10(0.72,1.69)
No	216(50.3)	34(15.7)	182(84.3)	Ref
Smoking during the second trimester				
Yes	73(17.1)	18(24.7)	55(75.3)	**1.68(1.05,2.69)**
No	354(82.9)	52(14.7)	302(85.3)	Ref
Parity				
≥ 1 previous live births	285(66.4)	47(16.5)	238(83.5)	0.99(0.63,1.55)
No previous live births	144(33.6)	24(16.7)	120(83.3)	Ref
Family resources scale: Nonessential time subscale				
Quartile 1 (more)(7-9)	124(29.2)	15(12.1)	109(87.9)	Ref
Quartile 2 (10-12)	102(24.0)	11(10.8)	91(89.2)	0.89(0.43,1.85)
Quartile 3 (13-17)	110(25.9)	20(18.2)	90(81.8)	1.50(0.81,2.79)
Quartile 4 (less)(18-35)	89(20.9)	23(25.8)	66(74.2)	**2.14(1.18,3.86)**
Top quartile (≥18)	89(20.9)	23(25.8)	66(74.2)	**1.89(1.21,2.94)**
Lower 3 quartiles (<18)	336(79.1)	46(13.7)	290(86.3)	Ref
Family resources scale: Nonessential money subscale				
Quartile 1 (more)(5-9)	133(31.2)	13(9.8)	120(90.2)	Ref
Quartile 2 (10-14)	129(30.2)	20(15.5)	109(84.5)	1.59(0.82,3.05)
Quartile 3 (15-18)	97(22.7)	16(16.5)	81(83.5)	1.69(0.85,3.34)
Quartile 4 (less)(19-24)	68(15.9)	22(32.4)	46(67.7)	**3.31(1.78,6.15)**
Top quartile (≥19)	68(15.9)	22(32.4)	46(67.6)	**2.37(1.54,3.65)**
Lower 3 quartiles (<19)	359(84.1)	49(13.7)	310(86.3)	Ref
Maternal Psychosocial Factors (Moderators)				
Depressive symptoms				
CESD =>16	176(41.0)	40(22.7)	136(77.3)	**1.85(1.21,2.84)**
CESD <16	253(59.0)	31(12.3)	222(87.8)	Ref

Table 1 (cont'd)

Stress				
Quartile 1 (Less stress) (12-14)	116(27.4)	11(9.5)	105(90.5)	Ref
Quartile 2 (15-17)	114(26.9)	16(14.0)	98(86.0)	1.48(0.72,3.05)
Quartile 3 (18-21)	93(21.9)	18(19.4)	75(80.7)	**2.04(1.01,4.10)**
Quartile 4 (More stress) (22-39)	101(23.8)	24(23.8)	77(76.2)	**2.51(1.29,4.86)**
Top quartile (≥22)	101(23.8)	24(23.8)	77(76.2)	**1.71(1.10,2.65)**
Lower 3 quartiles (<22)	323(76.2)	45(13.9)	278(86.1)	Ref
Social support				
Quartile 1 (Low)(13-38)	84(19.6)	24(28.6)	60(71.4)	**2.00(1.17,3.42)**
Quartile 2 (39-47)	123(28.7)	19(15.5)	104(84.6)	1.08(0.60,1.94)
Quartile 3 (48-52)	89(20.8)	9(10.1)	80(89.9)	0.71(0.34,1.49)
Quartile 4 (High) (53-55)	133(31.0)	19(14.3)	114(85.7)	Ref
Top quartile (≥53)	133(31.0)	19(14.3)	114(85.7)	Ref
Lower three quartiles (<53)	296(69.0)	52(17.6)	244(82.4)	1.23(0.76.1.20)
Racism Lifetime experiences				
Quartile 1(Fewer experiences) (1-6)	79(18.4)	12(15.2)	67(84.8)	Ref
Quartile 2 (7-9)	101(23.5)	16(15.8)	85(84.2)	1.04(0.52,2.08)
Quartile 3 (10-13)	102(23.8)	16(15.7)	86(84.3)	1.03(0.52,2.06)
Quartile 4 (More experiences) (14-30)	147(34.3)	27(18.4)	120(81.6)	1.21(0.65,2.25)
Top quartile (≥14)	147(34.3)	27(18.4)	120(81.6)	1.18(0.76,1.82)
Lower 3 quartiles (<14)	282(65.7)	44(15.6)	238(84.4)	Ref

Abbreviations: **CI** = confidence interval, **Ref** = reference, **PR** = prevalence ratio
Bolded values indicate estimates with 95% CIs that do not cross the null value

Table 2: Maternal characteristics by job strain categories, Baltimore study (N=429)

Characteristics	N	Active N(%)	High strain N(%)	Passive N(%)	Low strain N(%)	Chi-square P-value
Maternal age (Years)						
≤19	79	11(11.4)	19(20.4)	24(21.0)	24(19.2)	
20-24	190	41(42.7)	35(37.6)	55(48.3)	59(47.2)	0.336
25-29	99	28(29.2)	25(26.9)	23(20.2)	23(18.4)	
30+	61	16(16.7)	14(15.1)	12(10.5)	19(15.2)	
Maternal Education						
Less than high school	144	16(16.7)	46(49.5)	44(38.6)	37(29.6)	
High school diploma /GED	225	59(61.4)	40(43.0)	54(47.4)	72(57.6)	**<.0001**
Beyond high school	60	21(21.9)	7(7.5)	16(14.0)	16(12.8)	
Married/Cohabiting						
Yes	213	51(53.1)	44(47.3)	62(54.4)	55(44.0)	0.350
No	216	45(46.9)	49(52.7)	52(45.6)	70(56.0)	
Smoking during the second trimester						
Yes	73	12(12.5)	24(26.1)	22(19.3)	15(12.1)	**0.026**
No	354	84(87.5)	68(73.9)	92(80.7)	109(87.9)	
Parity						
≥ 1 previous live births	285	65(67.7)	62(66.7)	76(66.7)	82(65.6)	0.991
No previous live births	144	31(32.3)	31(33.3)	38(33.3)	43(34.4)	
Family resources scale: time subscale						
Quartile 1	124	31(33.3)	23(24.7)	33(29.0)	37(29.8)	
Quartile 2	102	18(19.4)	22(23.7)	32(28.1)	30(24.2)	0.696
Quartile 3	110	25(26.9)	24(25.8)	24(21.0)	36(29.0)	
Quartile 4	89	19(20.4)	24(25.8)	25(21.9)	21(16.9)	
Family resources scale: money subscale						
Quartile 1	133	34(35.4)	17(18.3)	33(29.2)	48(38.7)	
Quartile 2	129	31(32.3)	28(30.1)	33(29.2)	37(29.8)	**0.057**
Quartile 3	97	20(20.8)	30(32.3)	25(22.1)	22(17.7)	
Quartile 4	68	11(11.5)	18(19.3)	22(19.5)	17(13.7)	
Depressive symptoms						
CESD =>16	176	39(40.6)	44(47.3)	48(42.1)	44(35.2)	0.343
CESD <16	253	57(59.4)	49(52.7)	66(57.9)	81(64.8)	
Stress						
Quartile 1 (Less stress)	116	25(26.6)	26(28.3)	28(24.8)	37(29.8)	
Quartile 2	114	29(30.9)	15(16.3)	34(30.1)	36(29.0)	0.395
Quartile 3	93	18(19.1)	22(23.9)	25(22.1)	27(21.8)	
Quartile 4 (More stress)	101	22(23.4)	29(31.5)	26(23.0)	24(19.4)	
Social support						
Quartile 1	84	22(22.9)	23(24.7)	21(18.4)	18(14.4)	
Quartile 2	123	13(13.5)	30(32.3)	38(33.3)	41(32.8)	**0.016**
Quartile 3	89	27(28.1)	17(18.3)	24(21.1)	21(16.8)	
Quartile 4	133	34(35.4)	23(24.7)	31(27.2)	45(36.0)	

Table 2 (cont'd)

Racism Lifetime experiences						
1 Lowest quartile (Fewer experiences)	79	14(14.6)	13(14.0)	24(21.1)	28(22.4)	
2	101	20(20.8)	17(18.3)	35(30.7)	29(23.2)	0.153
3	102	25(26.0)	30(32.3)	21(18.4)	26(20.8)	
4 Highest quartile (More frequent experiences)	147	37(38.5)	33(35.5)	34(29.8)	42(33.6)	

Active job: high control and high demands; **High strain job:** low control and high demands; **Passive job:** low control and low demands; **Low strain job**: high control and low demands.

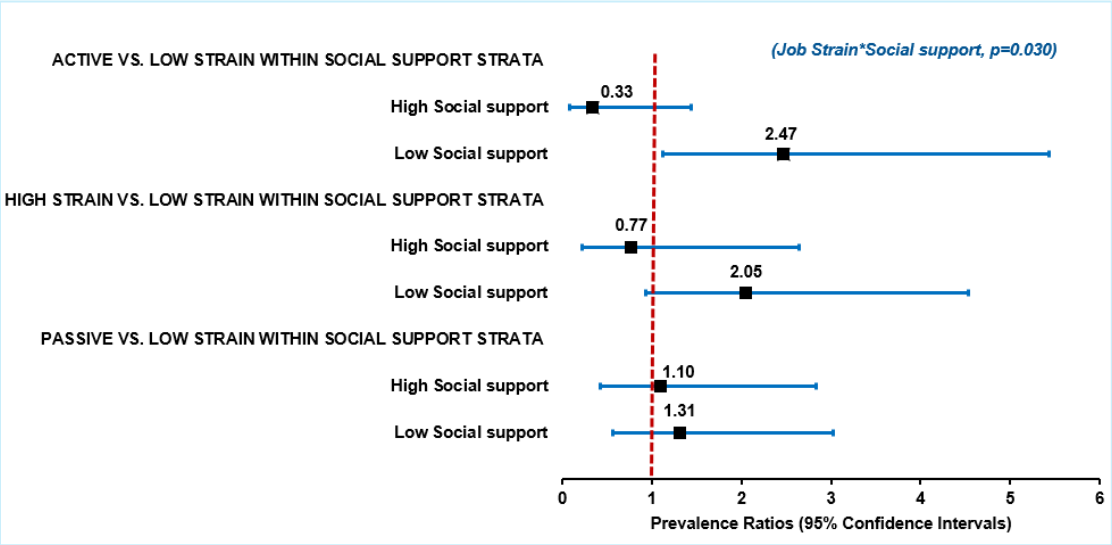
Table 3: Univariate and multivariable analyses of job strain and the risk of preterm birth (N=429)

	N	Preterm N(%)	Unadjusted PR(95% CI)	Adjusted* aPR(95% CI)
Job strain				
Active job (High control, High demands)	96	18(18.8)	1.46(0.79,2.72)	1.42(0.76,2.66)
High strain job (Low control, High demands)	93	19(20.4)	1.60(0.87,2.93)	1.47(0.80,2.71)
Passive job (Low control, Low demands)	114	18(15.8)	1.23(0.66,2.30)	1.12(0.61,2.09)
Low strain job (High control, Low demands)	125	16(12.8)	Ref	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family money resources.

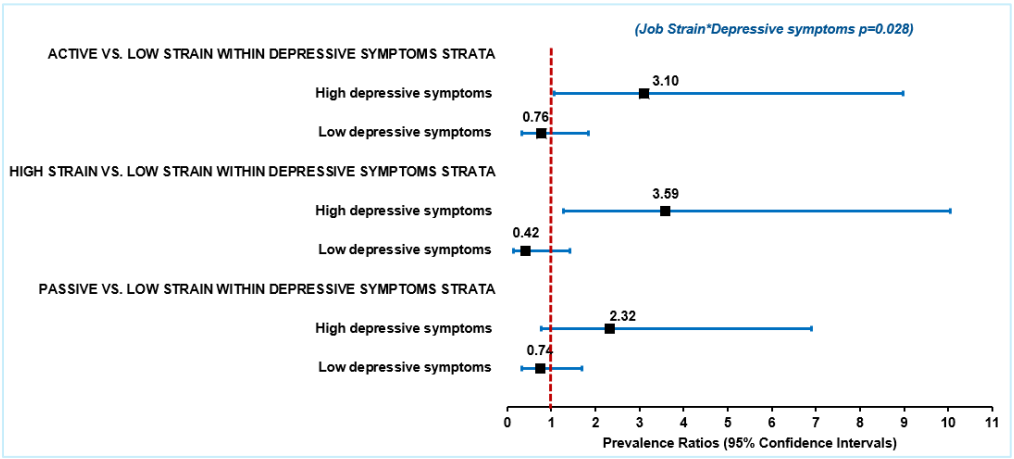
PR: Prevalence Ratio **aPR:** Adjusted Prevalence Ratio **CI:** Confidence Interval

Figure 2: Job strain-related differences in risk of preterm birth within strata of social support



Active job: high control and high demands; **High strain job:** low control and high demands; **Passive job:** low control and low demands; **low strain job**: high control and low demands

Figure 3: Job strain-related differences in risk of preterm birth within strata of depressive symptoms



Active job: high control and high demands; **High strain job:** low control and high demands; **Passive job:** low control and low demands; **low strain job**: high control and low demands

Figure 4: Tertile job strain-related differences in risk of preterm birth within strata of depressive symptoms

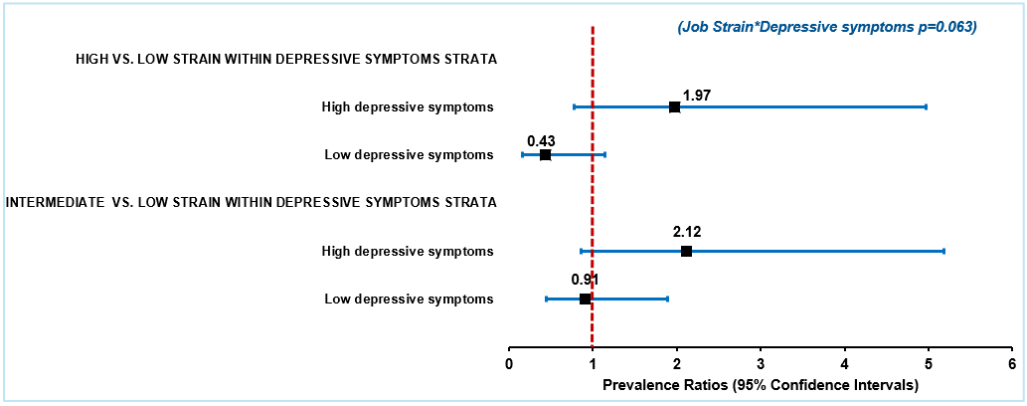
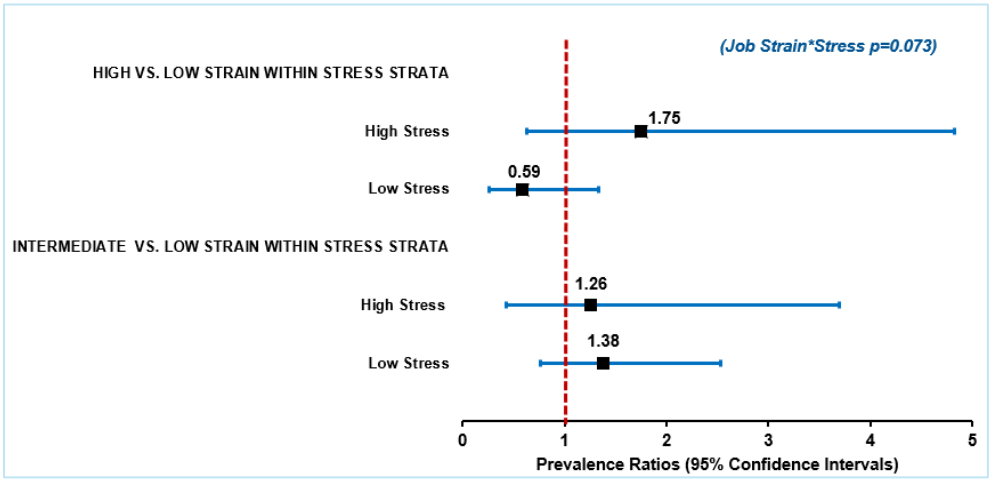


Figure 5: Tertile job strain-related differences in risk of preterm birth within strata of stress



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APPENDIX C

Supplementary Tables (S1-S3)

Table S1: Univariate and multivariable analyses of tertile job strain and preterm birth

	N	Preterm N(%)	Unadjusted PR(95% CI)	Adjusted* aPR(95% CI)
Job control[+]			0.98(0.92,1.03)	0.98(0.93,1.04)
Job demand[+]			1.04(0.98,1.11)	1.04(0.98,1.12)
Job control tertiles				
High job control	135	20(14.8)	Ref	
Intermediate job control	141	27(19.2)	1.29(0.76,2.19)	1.29(0.76,2.18)
Low job control	153	24(15.7)	1.06(0.61,1.83)	0.99(0.56,1.70)
Job demand tertiles				
High job demand	127	30(23.6)	1.35(0.83,2.19)	1.35(0.83,2.19)
Intermediate job demand	170	18(10.6)	0.60(0.34,1.07)	0.62(0.35,1.10)
Low job demand	131	23(17.6)	Ref	
Job strain using tertiles				
High job strain	140	21(15.0)	1.07(0.60,1.91)	1.00(0.56,17.9)
Intermediate job strain	160	32(20.0)	1.42(0.84,2.41)	1.36(0.81,2.27)
Low job strain	128	18(14.1)	Ref	

*****Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family money resources.
PR: Prevalence Ratio **aPR:** Adjusted Prevalence Ratio **CI:** Confidence Interval
[+] Modeled as a continuous exposure

Table S2: Job strain-related differences within strata of psychosocial factors and racism

Model terms	Stratum	Work factor PR adjusted*	Interaction *P*-value
Job strain and social support			
Active*social support	High social support	0.33(0.08,1.44)	***P* = 0.030**
	Low social support	**2.47(1.12,5.44)**	
High strain*social support	High social support	0.77(0.22,2.64)	
	Low social support	2.05(0.93,4.53)	
Passive*social support	High social support	1.10(0.43,2.83)	
	Low social support	1.31(0.57,3.03)	
Job strain and depressive symptoms			
Active*depressive symptoms	High depressive symptoms	**3.10(1.07,8.98)**	***P* = 0.028**
	Low depressive symptoms	0.76(0.32,1.85)	
High strain*depressive symptoms	High depressive symptoms	**3.59(1.28,10.05)**	
	Low depressive symptoms	0.42(0.13,1.42)	
Passive*depressive symptoms	High depressive symptoms	2.32(0.78,6.89)	
	Low depressive symptoms	0.74(0.32,1.70)	
Job strain and stress			
Active*stress	High stress	1.92(0.66,5.62)	*P* = 0.520
	Low stress	1.13(0.51,2.52)	
High strain*stress	High stress	1.78(0.60,5.23)	
	Low stress	1.17(0.52,2.62)	
Passive*stress	High stress	0.89(0.25,3.23)	
	Low stress	1.26(0.62,2.58)	
Job strain and racism			
Active*racism	High racism	0.81(0.32,2.10)	*P* = 0.325
	Low racism	2.22(0.93,5.29)	
High strain*racism	High racism	0.79(0.29,2.15)	
	Low racism	2.31(0.98,5.42)	
Passive*racism	High racism	0.70(0.28,1.74)	
	Low racism	1.65(0.69,3.95)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

aPR: Adjusted Prevalence Ratio **CI**: Confidence Interval

Active job: high control and high demand; **High strain job:** low control and high demand; **Passive job:** low control and low demand; **Low strain job**: high control and low demand

Table S3: Tertile job strain-related differences within strata of psychosocial factors and racism

Model terms	Stratum	Work factor PR adjusted*	Interaction *P*-value
Job strain and social support			
High strain*social support	High social support	0.61(0.17,2.18)	*P* = 0.652
	Low social support	1.17(0.59,2.33)	
Intermediate strain*social support	High social support	1.22(0.50,3.02)	
	Low social support	1.45(0.76,2.76)	
Job strain and depressive symptoms			
High strain*depressive symptoms	High depressive symptoms	1.97(0.78,4.97)	***P* = 0.063**
	Low depressive symptoms	0.43(0.16,1.14)	
Intermediate strain*depressive symptoms	High depressive symptoms	2.12(0.86,5.19)	
	Low depressive symptoms	0.91(0.45,1.89)	
Job strain and stress			
High strain*stress	High stress	1.75(0.63,4.83)	***P* = 0.073**
	Low stress	0.59(0.26,1.34)	
Intermediate strain*stress	High stress	1.26(0.43,3.70)	
	Low stress	1.38(0.76,2.53)	
Job strain and racism			
High strain*racism	High racism	0.50(0.19,1.34)	*P* = 0.147
	Low racism	1.60(0.72,3.54)	
Intermediate strain*racism	High racism	0.84(0.40,1.78)	
	Low racism	1.97(0.93,4.17)	

*Adjusted for Marital status, Maternal age, education, Smoking during the second trimester, parity, and family resource scale: money

aPR: Adjusted Prevalence Ratio **CI**: Confidence Interval

CHAPTER 7: DISCUSSION

7.1 Summary of Findings

How work impacts the risk of preterm birth (PTB) has not been extensively studied among Black women in the U.S., the group that is disproportionately affected by PTB.[1] This dissertation aimed to evaluate the relationship between work exposures (work hours, physical demands, psychological demands, job strain) and PTB among Black mothers and to investigate if psychosocial factors and life experiences of racism moderated the associations. Specifically, we addressed 3 aims: 1) Evaluate the associations between multiple domains of work (number of hours of work, physical demands, psychological demands) and preterm birth, 2) Evaluate the impact of job strain on the risk of preterm birth, 3) Evaluate whether the association between work exposures (work domains, job strain) and PTB differs according to social support, depressive symptoms, perceived stress, and lifetime experiences of racism. The overarching hypothesis was that preterm birth will be elevated in pregnant women who are working for prolonged hours (> 40 hours per week), involved in physically and psychologically demanding work activities, PTB will vary by job strain and that the impact of work on PTB will differ by social support, depressive symptoms, stress and lifetime experiences of racism.

7.1.1 Prolonged work hours, physical demands, and PTB

We found a positive, nonsignificant association between working for prolonged hours and PTB. We did not find any significant association with the physical demands composite. Further analyses focused on individual physical demands measures showed a modest, albeit non-significant, positive association between heavy lifting and PTB.

Findings from our study also indicated a modest protective effect for women who worked for long periods with bodies in physically awkward positions. There was no association between specific individual physical demand measures (physical effort and rapid and continuous physical activity) examined as separate exposures with PTB.

7.1.2 Psychological Demands and PTB

In our study, having the highest psychologically demanding work (top quartile vs. lower three quartiles) was significantly associated with PTB. When we explored individual psychological demand measures, we found that women with excessive work and those who did not have enough time to complete their work had increased PTB, but the associations were not statistically significant. There was no association between specific individual psychological demand measures (working very fast, working very hard, conflicting demands, long periods of intense concentration, tasks often interrupted, and very hectic work) examined as separate exposures with PTB.

7.1.3 Job strain and PTB

Median score job strain categories

Compared to low strain jobs, our study found a modest but non-significant increase in PTB risk among women with high strain and active jobs and a weak non-significant association with passive jobs.

Tertile-based job strain categories

Compared to low strain jobs, the findings from our study demonstrated a modest, non-significant PTB association with intermediate job strain jobs but no association with high strain jobs.

7.1.4 Moderation

In contrast to previous publications, and unique to our study, we explored the potential for moderation by psychosocial factors and lifetime experiences of racism for the relationship between work exposures (work domains, job strain) and PTB. Additionally, we explored the timing of recruitment, and thus data collection, as a potential moderator for PTB and work hours and physical demands associations.

7.1.4.1 Work hours

In our study, the timing of recruitment moderated the association between hours worked and PTB rates, such that working prolonged hours (more than 40 hours per week) was associated with high PTB rates among women enrolled during their postpartum hospitalization.

Neither psychosocial factors nor lifetime experience of racism moderated the association between prolonged hours and PTB.

7.1.4.2 Physical demands of work

Social support moderated the relationship between PTB and working with physically awkward body positions in a protective way, as women whose jobs involved physically awkward body positions with high social support were less likely to experience PTB than those with low social support. Further, social support moderated the relationship between high physical demand score (above or at the median) and PTB, such that highly physically demanding work was associated with PTB among women with low social support.

Depressive symptoms, stress, or lifetime experiences of racism did not modify the physical demands-PTB association. Further, there was no indication of moderation by the timing of recruitment.

7.1.4.3 Psychological demands of work

We found that social support and depressive symptoms both (individually) moderated the relationship between high psychological demands and PTB. Women with low social support and high psychological work demands experienced elevated PTB rates. Prevalence ratios were also elevated for high psychological work demands among women with high depressive symptoms.

We also observed moderation by psychosocial factors for the relationship between PTB and some individual measures of psychological demands. Depressive symptoms moderated the relationship between working very hectic jobs and PTB. Women whose jobs were very hectic and who had high depressive symptoms were at increased risk of PTB. However, there was a protective effect on PTB for women with the same working conditions but with low depressive symptoms. Stress moderated the relationship between working long periods with intense concentration and PTB. Among women with high stress, working long periods with intense concentration was significantly associated with a 3-fold increase in PTB. Social support moderated the relationship between working very hard and PTB but in a protective way, as women whose jobs involved working very hard but had high social support were less likely to experience preterm birth. Similarly, social support moderated the relationship between working long periods with intense concentration and PTB.

7.1.4.4 Job strain

Median score job strain categories

Social support moderated the relationship between job strain and PTB, such that high strain and active jobs were associated with elevated PTB risk among women with low social support, while high social support buffered the effect of job strain on PTB risk.

Our study also demonstrated that depressive symptoms moderated the relationship between job strain and PTB, such that having active and high strain jobs was significantly associated with increased PTB rates among women with high depressive symptoms. Similarly, having a passive job was associated with high PTB rates among women with high depressive symptoms, but the association was not statistically significant. We found no evidence of moderation of the work strain-PTB associations by perceived stress or racism.

Tertile-based job strain categories

Depressive symptoms moderated the relationship between job strain and PTB, consistent with what we found for job strain based on median cutpoints. Compared to low strain jobs, high strain and intermediate strain jobs were associated with elevated PTB risk among women with high depressive symptoms, while low depressive symptoms buffered the effect of job strain on PTB risk.

In contrast to our models of job strain based on medians, stress moderated the relationship between job strain and PTB. Compared to low strain jobs, high strain and intermediate strain jobs were associated with increased PTB risk among women with high stress, while low stress buffered the effect of high strain jobs on PTB risk but not for intermediate strain jobs.

Social support was not a moderator for the models using job strain based on tertiles, unlike what we found for job strain based on medians. Neither the median nor the tertile-based models of strain showed any evidence of multiplicative interaction with lifetime experiences of racism.

Overall, no moderation was seen for the work exposures (work domains, job strain)-PTB association by racism on the multiplicative scale. Our study had 86% of the women aged ≤ 29 years; this may have been a limitation for our study to capture the effects of lifetime experiences of racism, as such experiences may greatly impact older women who have been exposed for a more extended period.[2] Further, experiences of racism may be important in the workplace context for PTB, but our specific measures may not have captured them. In our future studies, we will consider evaluating racism experiences specific to the workplace to capture the effect of racism.

Our findings suggest that working for prolonged hours and having a job that has psychologically and physically demanding activities and job strain may increase PTB rates in Black women. The evidence of interactions based on a multiplicative scale between 1) prolonged work hours and timing of recruitment, 2) physical demands of work and social support, 3) psychological demands of work and psychosocial factors, and 4) job strain and psychosocial factors show that the impacts are intertwined. Intervention efforts should focus on addressing these work exposures and psychosocial factors.

7.2 Review of Limitations

Limitations for this dissertation were covered in detail in the discussion sections for each manuscript in chapters 2 to 4. Worth noting is that despite the parent study being a cohort, the data utilized for most of our analysis was collected at a single point during pregnancy. Using cross-sectional data for many analyses limits the ability to infer causality between work exposures and PTB risk. Similar to prior studies, our study utilized cohort data from the early 2000s. Over the past twenty years, the prevalence of

work exposures for Black women may have changed, but we do know that the PTB rates for Black women have not appreciably improved since the study was completed. Contextual factors like stress and social support may also have changed, but our study's strength was the exploration of these factors through moderation analysis. Secular changes have also occurred over the past twenty years, including the recent passage of the U.S. 2024 Pregnant Fair Workers Act, requiring employers to accommodate pregnant women.[3] This legislation provides an opportunity for data-driven protection. Further, we do not know whether there was a change in work status during pregnancy, such as women taking sick leave, especially if they have low control at their workplaces. This may have led to an underestimation of the actual effect of the exposure on PTB.[4] Further, our study did not explore moderation on an additive scale, a beneficial scale in identifying at-risk groups and prioritizing such groups when implementing interventions.[5] We hope to conduct similar work in future studies to track work status changes during pregnancy and address how present-day jobs may affect women's risk.

7.3 Results in the context of prior evidence

This dissertation is the first to investigate the associations between PTB and work exposures (physical demands, psychological demands, and job strain) using the Karasek comprehensive measurement tool in a cohort of only Black women. How the work environment relates to the risk of PTB preterm birth is a relatively less studied area, particularly among Black women who experience the highest risk for PTB in the United States. Consistent with our findings, prior studies have reported statistically non-significant associations between physical demands and PTB.[6–9] Our findings contradict

others that have reported significant PTB associations with high physical demands.[10–15] Of these studies, only Bell et al.[13] included data for Black women and reported on the physical demands-PTB association. The authors reported significantly increased PTB risk for Black women involved in highly physically demanding work compared to White women. However, this study used job titles to obtain exposure information, which is not subject to recall bias but may not consider individual variability and may miss out on differences by duration of exposure.[16] Our study obtained exposure information using women's responses from the Karasek job demand and control questionnaire.

Only two prior studies[11,17] have considered the effect of psychological demands of the work environment on PTB separate from the worker's control, and the findings from these studies were not significant. Further, only Meyer et al.[17] included data for Black women and did not report on the stratified results by maternal race but considered race as a confounder. Our dissertation work is the second, after Meyer et al.,[17] to utilize Karasek's JDC[18] questionnaire to assess the individual effect of psychological work conditions on PTB risk and the first to evaluate the psychological demands of work in a cohort of only Black women.

Our dissertation work is the second after the work of Brett et al.[16] 1997 US case-control study to examine the impact of job strain on PTB among Black women. Similar to our findings, Brett et al. reported elevated but non-significant PTB rates among Black women who had high strain jobs. In contrast to our findings, when Brett et al. constrained exposure occurrence to 30 or more weeks, PTB rates were significantly higher for women with high strain jobs compared to those with low strain jobs. The rest

of the previous studies that reported significant associations were case control,[11,12,14,15] hence subject to recall bias.

Our dissertation is the first one to evaluate the moderating role of the timing of recruitment on the PTB-prolonged work hours associations. Our dissertation work is the first to evaluate the moderating role of depressive symptoms, stress, and racism on work exposure and PTB associations based on a multiplicative scale. Previous studies have not evaluated the moderating role of psychosocial factors, except for three studies[4,19,20] that considered the moderating role of social support in the workplace on the job strain-PTB association. Our findings suggest that low social support may amplify the effect of work exposures (physical demands, psychological demands, and job strain) on PTB, while high social support may buffer this relationship. High social support may provide women with resources like positive interactions with social networks at and outside the workplace, which may alleviate the effect of job strain on PTB.

Our findings suggest that high depressive symptoms may amplify the effect of work exposures (psychological demands and job strain) on PTB, while low depressive symptoms may buffer this relationship. Further, our findings indicated that high stress amplified the individual measure of psychological demands (working long periods with intense concentration) and PTB association. Similarly, high stress amplified the job strain and PTB association.

Our findings suggest that without considering the role of psychosocial factors that women may be experiencing, the effect of work exposures on PTB risk may be missed because they are synergistic. Such factors have been explored outside the workplace

and found to be associated with PTB[21,22] and also reported to be important moderators.[23–25]

7.4 Directions for Future Research

Our dissertation findings suggest that working for prolonged hours and having a job that has psychological demands, physical demands, and job strain may increase PTB rates in Black women. The evidence of interactions based on a multiplicative scale between 1) prolonged work hours and timing of recruitment, 2) physical demands of work and social support, 3) psychological demands of work and psychosocial factors, and 4) job strain and psychosocial factors show that the impacts are intertwined. Future studies should consider how psychosocial factors may be interrelated with work exposures.

In our dissertation, there was no moderation by lifetime experiences of racism, and this may be due to the majority of our women being younger since such experiences greatly impact older women who have been exposed for a more extended period. Future studies should consider a broader age distribution to explore the effect of life experiences of racism on the work exposure-PTB association. Further, such experiences may be important in the workplace context for PTB, but our specific measure may not have captured them. Future studies should consider evaluating racism experiences specific to the workplace to capture the effect of racism.

This dissertation utilized data from a cohort conducted in the early 2000s. Secular changes have also occurred over the past twenty years, including the recent passage of the U.S. 2024 Pregnant Fair Workers Act, requiring employers to accommodate pregnant women.[3] While such changes may affect the prevalence of

work exposures, the prevalence of PTB has barely improved for Black women over the years. Contextual factors like depression, stress, and social support may also have changed. However, a strength of our dissertation work is the exploration of contextual factors through moderation analyses. We have little reason to expect that the associations would have changed over time, but it is a limitation of our study. We hope to conduct similar work in the future to address changes in the workplace. Further, for our dissertation work, we do not know whether there was a change in work status during pregnancy, such as women taking sick leave, especially if they have low control at their workplaces. We hope to conduct similar work in future studies to track work status changes during pregnancy and address how present-day jobs may affect women's risk.

7.5 Public Health Implications

Findings from this dissertation have essential public health implications, and the information can be used to guide policies in the workplace environment. Understanding how work may increase or decrease the risk of PTB among Black mothers provides additional insight to mitigate modifiable determinants that drive racial disparities. However, it is critical to note that workforce inequities result from social forces that may determine where women work and the jobs they are involved in and, therefore, workplace exposures that may increase their risk to PTB. Developing research strategies that reduce PTB in high-risk populations is vital and contributes toward decreasing national PTB rates. These findings are beneficial in raising public health awareness of pregnant women on the impact of stresses in the work environment on pregnancy outcomes.

The unique aspect of our dissertation is evaluating the moderation effect of psychosocial factors and racism, contextual factors experienced by Black women. Evidence of interactions between work exposures and psychosocial factors suggest that impacts are intertwined. Intervention efforts need to focus on addressing work exposures and psychosocial factors.

The findings of this dissertation highlight the need for social and economic policies to improve the livelihood of pregnant women in the workforce. Further, our findings add to the evidence of the impact of work exposures on pregnancy outcomes. They can be utilized to support the incorporation of accommodations for pregnant women in the work environment, which would align with the US 2024 Pregnant Fair Workers Act.[3] Some accommodations that may be helpful for pregnant women may include reducing physical strenuous activities within the job role (heavy lifting, awkward body positioning) and flexible working hours. However, it's important to note that the connections and social support from colleagues and managers that pregnant women have in the workplace may impact whether or not they ask for such accommodations.

7.6 Conclusion

This dissertation investigated the impact of work exposures (work hours, physical work demands, psychological work demands, and job strain) on PTB among Black women. Further, we evaluated if psychosocial factors and racism moderated the associations. Findings from the dissertation suggest that physically demanding work activities involving heavy lifting and working for prolonged hours may increase PTB rates in Black women with evidence of interactions with social support. We found that Black women whose work involves psychologically demanding work activities are at

elevated risk of PTB with evidence of interactions with psychosocial factors. Further, our results indicated that pregnant Black women with active and high strain jobs have elevated PTB rates after considering moderators, specifically social support and depressive symptoms. Evidence of interactions between the work exposures and psychosocial factors suggest that impacts are intertwined. There is a need to develop intervention efforts that address both work exposures and psychosocial factors. The findings highlight the need for policies and measures that provide an accommodative work environment for pregnant women to ensure better pregnancy outcomes.

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