THE TIPPING POINT: AN INVESTIGATION OF THE EFFECTS OF SUBMINIMUM WAGE ON MATERNAL AND CHILD HEALTH

By

Sarah Beth Andrea, MPH

A DISSERTATION

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CERTIFICATE OF APPROVAL

This is to certify that the PhD dissertation of

Sarah Beth Andrea, MPH

has been approved

Janne Boone-Heinonen, PhD, MPH

Lynne C. Messer, PhD, MPH

Miguel Marino, PhD, MS

Julia M. Goodman, PhD, MPH

DEDICATION

For Mom and June Bug, my forever heroines and inspiration for this work

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ABSTRACT OF THE DISSERTATION
The tipping point: an investigation of the effects of subminimum wage on maternal and child health

By

Sarah Beth Andrea, MPH
Doctor of Philosophy in Epidemiology
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Professor Janne Boone-Heinonen, Chair

Precarious work is concentrated in the service industry in the United States and is a risk factor for poor mental health. Service occupations in which workers receive tips are potentially more precarious due to unstable schedule, income, and lack of benefits. Tipped workers, primarily women of reproductive-age, can be paid a "subminimum wage" that is 71% lower than the federal minimum wage, contributing to their economic hardship. Despite abundant research linking poverty to poor mental health, the effects of wage-related policies on mental health in women are unknown. This dissertation investigated the potential consequences of tipped service work for reproductive-aged women as well as one potential policy intervention: increasing the subminimum wage.

First, I utilized data from the National Longitudinal Study of Adolescent to Adult Health to test the hypothesis that women in tipped occupations have a higher burden of depression relative to women in other occupations (Aim 1). To improve comparability of occupation types, I computed propensity-scores as a function of childhood factors, then used these scores to construct the analytic sample of 2,815 women and 2,586 men. I observed that young women in tipped service occupations experience a greater burden of depression than similar women in other occupation types.

For subsequent aims, I leveraged natural experiments in subminimum wage laws across states and time, and linked state-level wage laws, census, and antipoverty policy data to individual-level surveillance data.

In Aim 2, I utilized data from the Pregnancy Risk Assessment Monitoring System (364,588 women from 35 states giving birth 2004-2014), and applied difference-in-difference analyses to test the hypothesis that higher state-level subminimum wage is associated with less poverty-related stress during pregnancy. I observed that increases in subminimum wage were associated with a reduction in poverty-related stress and that setting the subminimum wage to 100% of the federal minimum wage (i.e. essentially eliminating a subminimum wage) was the only strategy that was not associated with increases in stress in recent years for the most vulnerable women.

In Aim 3, I utilized data from the National Vital Statistics System birth data (41,219,953 infants born to women in all 50 states and the District of Columbia between 2004-2016), and applied difference-in-difference analyses with unconditional quantile regression to test the hypothesis that higher state-level subminimum wage is associated with healthier birthweight for gestational age in infants. I observed that increases in subminimum wage are associated with an increase in birthweight for gestational age among the smallest infants and a decrease among the largest infants. Eliminating the subminimum wage was the only strategy that was not associated with further dispersion of the birthweight for gestational age distribution in recent years.

Taken together, reproductive age women in tipped service occupations experience a disproportionate burden of poor mental health and increasing the tipped worker subminimum wage has the potential to reduce poverty-related stress and mitigate intergenerational consequences.

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LIST OF ABBREVIATIONS

Add Health	National Longitudinal Study of Adolescent to Adult Health
AI/AN	American Indian or Alaskan Native
AUDIT-C	Alcohol Use Disorders Identification Test
BMI	Body Mass Index
BRFSS	Behavioral Risk Factor Surveillance System
BWz	Birthweight for Gestational Age Z-score
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
DOHaD	Developmental Origins of Health and Disease
EITC	Earned Income Tax Credit
FLSA	Fair Labor Standards Act
HPA	Hypothalamic-Pituitary-Adrenal
LBW	Low Birthweight
LGA	Large for Gestational Age
NVSS	National Vital Statistics System
NHOPI	Native Hawaiian or Pacific Islander
OR	Odds Ratio
PRAMS	Pregnancy Risk Assessment Monitoring System
PS	Propensity Score
RR	Relative Risk
SD	Standard Deviation
SE	Standard Error
SGA	Small for Gestational Age
US	United States
USD	United States Dollars

CHAPTER 1: Introduction & Research Aims

Twenty-five percent of women with incomes below the federal poverty level experience frequent depression, the leading cause of disability for 15- to 44-year-olds.[1,2] Despite abundant research linking poverty to poor mental health, the effects of wage-related policies on mental health in women are under-explored.

The approximately 3 million women working in tipped service occupations in the United States (US) may be particularly vulnerable to poor mental health.[3] Tipped work is precarious, that is, poorly paid, insecure, and with insufficient institutional protections. Tipped workers can be paid a wage 71% lower than the federal minimum wage, referred to hereafter as subminimum wage. Tipped workers are nearly twice as likely to have incomes below the federal poverty level relative to untipped workers.[3] Relative to individuals with higher incomes, low-income individuals are more likely to experience depression[4–8] likely reflecting disproportionately greater exposure to stressors such as poor working conditions,[9] financial strain (e.g. difficulty paying bills), and violence.[10] In fact, stress precedes the onset of depression in 85% of cases.[11] In addition, due to the unpredictable nature of customer tips and unstable work schedules, women in tipped occupations experience volatile income, which is similarly associated with financial hardship and subsequent depression.[12,13] While economic and industry research has emphasized experiences of poverty in the tipped workforce, there is a paucity of empirical research on the health of tipped workers.

Notably, the majority of individuals earning minimum wage or less are reproductive-aged women.[14] Depression prevalence peaks in reproductive-age among women[15] and it is one of the most common complications experienced by women during or following their pregnancy.[16] There is an established relationship between maternal socioeconomic

disadvantage,[17] stress,[18] and depression[19] with adverse birth outcomes, like low birthweight (LBW) and large for gestational age birth.[20] Notably, infants born either small or large are at risk for poor health across the lifecourse.[21–24] Thus the disproportionate burden of depression among low-income women has important implications for the next generation. Recent studies have observed a relationship between increasing minimum wage and reductions in depression,[25] premature mortality,[26] adolescent birth rates,[27] LBW deliveries, and postneonatal mortality.[28,29] I therefore hypothesize that any effects of higher tipped worker subminimum wage on maternal health may translate to reduced disease susceptibility in their children.

This work represents the first investigation of the potential consequences of precarious tipped service work for reproductive-aged women as well as one potential intervention: raising the subminimum wage. This dissertation is organized as follows:

In Chapter 2, I begin with a review of the literature as it pertains to the risk factors and sequelae of depression for women and their children, poverty as a determinant of health, and my vulnerable subgroup of interest: tipped service workers.

In Chapter 3 (**Aim 1**), I test the hypothesis that reproductive-aged women working in tipped service experience greater odds of depression relative to similar women in: (1a) non-service and (1b) untipped service occupations using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). To address social stratification into occupation, I utilize propensity scores that incorporate childhood factors to construct an analytic sample of comparable participants in different occupation types. Moreover, I descriptively assess the distribution of differential work-related exposures like average hourly wages and availability of paid leave.

In Chapter 4 (**Aim 2**), I test the hypothesis that increases in state-level subminimum

wage are associated with reduced cumulative poverty-related antenatal stress in women using data from 364,588 women from 35 states participating in the Pregnancy Risk Assessment Monitoring System (PRAMS) between 2004 and 2014. I apply difference-in-differences analysis, an approach that provides robust estimates of policy effects, allowing for baseline differences between states while accounting for secular changes that should not be attributed to subminimum wage policy change. Moreover, to determine for whom and under what conditions increasing the subminimum wage is beneficial or detrimental, I assess heterogeneity of effects by individual-level characteristics theorized to contribute to differential exposure to tipped wage work (e.g. educational attainment) and differential vulnerability (e.g. race, marital status).

In Chapter 5 (**Aim 3**), I test the hypothesis that increases in state-level subminimum wage are associated with healthier birthweight in infants using birthweight and gestational age recorded in the birth records of 41,219,953 infants born to women in all 50 states and the District of Columbia between 2004 and 2016 (National Vital Statistics System, NVSS). I apply unconditional quantile regression to examine the nature of the association across the entirety of the birthweight for gestational age distribution and assess how changes in the subminimum wage impact the location and dispersion of the distribution.

In Chapter 6, I provide a summary of findings and conclusions from the three studies conducted as part of this dissertation as well as future research needs and policy implications.

Finally, the Appendices provide documentation from the Oregon Health & Science University Institutional Review Board as well as supplemental methods and results for each of the three studies.

CHAPTER 2: Literature Review

The long term goal of this project was to identify policy-level strategies to reduce the burden of poor health in vulnerable populations. This dissertation tests the hypotheses that young women in tipped work experience a greater burden of depression relative to similar women in other occupations and that increases in the tipped worker subminimum wage are associated with better health in women and their children. New knowledge acquired from researching these health outcomes in the present policy environment enable us to inform and improve policy and practices with potential for intergenerational effects.

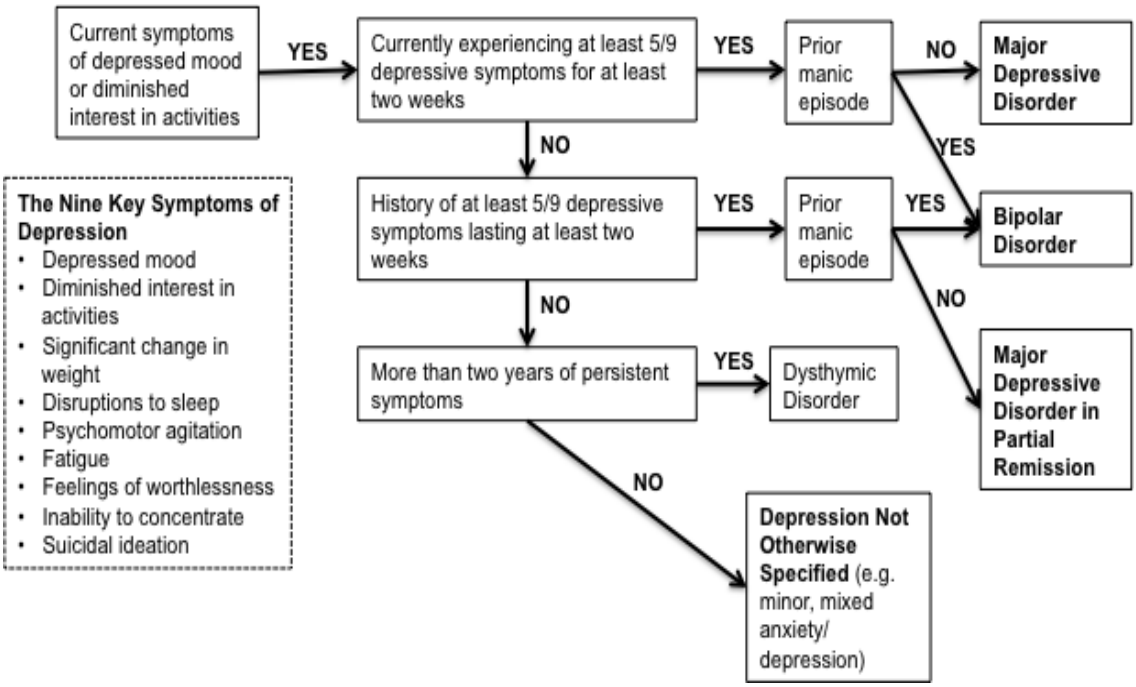
2.1.OUTCOME: Depression. The primary outcome of interest for this dissertation is depression in reproductive-aged women, with attention to stress as a key precursor and small or large for gestational age birth as a consequence with implications for intergenerational health. The following sections detail the scientific rationale for my focus on depression in reproductive-aged women.

2.1.1. Definitions, burden, and consequences. Depression is the largest contributor of disease burden in middle- and high-income countries,[30] affecting 6.7% of adults 18 and older in the United States (US) in a given year.[31] A diagnosis of depression is made in the presence of persistent depressive symptoms - such as depressed mood and disruptions to sleep or appetite[32] - typically lasting for a minimum of two weeks.[33] Clinical depression is classified as a mood disorder; subtypes vary in terms of course, comorbidity with manic systems, severity, and subsequent treatment implications.[16] Depression without lifetime mania or hypomania - or unipolar major depressive disorder - is the most common type of mood disorder.[16] **Figure 2.1** displays a simplified differential diagnosis of mood disorders strategy as driven primarily by symptoms and duration. This project focuses in particular on unipolar mood disorders, which can be

acute or chronic with symptoms that range from mild to severe.[33]

Depression frequently develops in adolescence and early adulthood[34] and is often recurrent in nature, which can lead to substantial impairments in one's ability to attend to their daily responsibilities.[32] Major depressive disorder in particular is the leading cause of disability for 15- to 44-year-olds.[35] Chronic depression has been linked to physical changes in the brain.[36] Moreover, through mechanisms such as decreased physical activity and social involvement, depression increases the risk of obesity[37] and heart disease in healthy people, and worsens the prognosis among those with heart disease.[38]

Figure 2.1 Differential diagnosis of mood disorders



2.1.2. Risk factors. Depression is an internalized disorder, however, risk factors for depression are largely external. These exogenous risk factors include exposure to early-life adversity (e.g. childhood maltreatment[39–41]), stressful life events (e.g. food

insecurity,[42] domestic violence),[43] and social factors (e.g. poor social support).[44] While there are also intrinsic risk factors for depression - namely, psychologic factors (e.g. personality)[45] and genetic factors - exposure to psychosocial stress precedes onset of depression in 85% of cases.[11] Moreover, even heritable genetic factors appear to often be the result of the gene-environment interaction,[46] further highlighting the need to focus on exogenous risk factors.

2.1.3. Physiologic relationship between stress and depression. Exposure to psychosocial stress increases vulnerability to depression throughout one's life course by altering sensitivity to stress and response to negative stimuli via persistent hyperactivity – or dysregulation – of the hypothalamic-pituitary-adrenal (HPA) axis.[36,47,48] This hyperactivity leads to the increased availability of corticotropin-releasing factor, and in turn causes the secretion of cortisol.[47,49] Cortisol is associated with hyperactivity of the amygdala, hypoactivity of the hippocampus, and decreased serotonergic neurotransmission. Through this process, exogenous stressors promote clinical levels of depression.[49] Finally, these permutations to the HPA-axis further increase one's vulnerability to future stress.

2.1.4. Populations disproportionately affected by depression. Because stress is perhaps the most important risk factor for depression, subpopulations exposed to additional acute and chronic stressors are particularly vulnerable.

2.1.4.1. Women. Women are 50% more likely to experience depression[50] in their lifetime relative to men. These gender differences may in part be definitional and reflect the gendered development of diagnostic criteria, which were developed using a selective sample of women only and grounded in historical gendered attributes (e.g. 'feminine' qualities).[51] In addition, hormonal changes attributed to the reproductive life cycle may

increase the lifetime risk of mood disorders such as depression in women,[52,53]particularly those with an underlying physiologic vulnerability to these changes,[54] implicating the role of biological differences. Finally, gender-based discrimination may play a role in gender-based differences in mental health, implicating social context. Gender-based discrimination is a theorized risk factor for depression;[55] gender-based discrimination is more strongly associated with depressive symptoms than generic stressors such as daily hassles (e.g. losing car keys) and major life events (e.g. getting married, getting fired).[56] Stress related to gender-based discrimination presents as: (1) Episodic stress from discrete instances (e.g. street harassment); (2) daily exposure to more subtle microaggressions (e.g. sexist humor); (3) chronic stress from the impact of structural sexism, which limits opportunities and access to resources (e.g. subordinate social status, income inequality).[55,57,58] Thus, the gender differences in depression likely reflect both definitional and biological differences as well as social context. The focus of this project is social context.

2.1.4.2. Minority Women. Gender differences in the prevalence of depression persist across racial and ethnic subgroups; lifetime prevalence of self-reported depression diagnosis is highest in multiracial non-Hispanic women (29.9%; BRFSS Web Enabled Analysis Tool). Moreover, prevalence of depression in non-White women may be underestimated. The original diagnostic criteria were likely developed based on a sample of white patients.[59] The literature further reveals an underreporting of depression, especially in Black communities which perceive depression as a “white illness”.[60] Studies comparing US-born women of minority race/ethnicity to immigrant women of the same race/ethnicity have found US-born women are more likely to have depression,[61,62] implying differences in the prevalence of depression by race and ethnicity cannot be reduced to biological differences. Again, social context is implied.

Particularly among Black women, experiences of gender-based discrimination are further compounded by experiences of racism.[63] As with gender-based discrimination, this racism-related stress presents as: (1) Episodic stress from discrete instances of direct racial discrimination; (2) daily exposure to more subtle racial microaggressions; and (3) chronic stress from the impact of structural racism, which limits opportunities and access to resources.[58,64,65] Racist representations of Black womanhood in particular make Black women vulnerable to sexual violence, discrimination, and sexism in ways that white women are not.[63] Exposure to the stressors of sexual objectification, racist events, and gendered racism are all strong predictors of depression in Black women.[66]

2.1.4.3. Pregnant Women. Pregnancy is a period of increased vulnerability for the onset or relapse of depression. The prevalence of depression peaks in women of reproductive age (15 to 44 years)[15] and it is one of the most common medical complications experienced by women during or following their pregnancy.[16] The period prevalence of any depressive disorder during pregnancy (antenatal depression) is 18.4%, nearly twice that of all reproductive aged women.[16,67] Pregnancy is a period of profound hormonal fluctuations, and the burden of antenatal depression in women may in part be attributed to these fluctuations.[68] However, pregnancy is also a major life event that may be accompanied by a host of acute and chronic pregnancy-related stressors. One systematic review found that pregnant women are particularly vulnerable to antenatal depression if they experience pregnancy-related stressors such as: lack of support from a partner or other social support, being in an abusive or otherwise problematic relationship, an unplanned or unwanted pregnancy, current or past pregnancy complications or pregnancy loss, and financial insecurity.[69] Women with prior histories of depression are also at risk for recurrent episodes or relapse during pregnancy in part due to the discontinuation of antidepressants.[70] One study found that 50% of pregnant

women with major depression are not receiving treatment.[67], while the reluctance among health providers to prescribe and among pregnant women[71] to take antidepressants during pregnancy is not unfounded, there are a variety of non-pharmacotherapy options (e.g., psychotherapy, acupuncture, omega-3 fatty acids).[72]

2.1.4.3.1 Depression as a marker for dysregulation of the maternal stress response. As briefly described in section 2.1.3, depression can be a physiologic consequence of the hyperactivity – or dysregulation – of the stress response.[73] While dysregulation of the HPA-axis does not always result in depression and dysregulation is not as prominently part of the pathogenesis for all types of depression,[74] presence of depression can be a marker for the dysregulation of the maternal stress response.

2.1.4.3.2 Maternal psychosocial stress exposure and depression prior to and during pregnancy has implications for the developing fetus. In the context of pregnancy, the maternal stress response system and that of the developing fetus are intrinsically linked. The dysregulated maternal stress response system has been implicated in the epigenetic transmission of adverse mental health, cognitive, and behavioral outcomes in their children.[75] Moreover, it is not just prenatal exposure but the accumulation of stress across a woman's entire developmental trajectory that may confer risk for poor health in their children.[76] Maternal stress and depression – as a product of a dysregulated stress response system[73] – are associated with differential fetal DNA methylation. This finding is consistent with the developmental origins of health and disease (DOHaD) hypothesis that maternal stress promotes an adverse *in utero* environment that can lead to differential programming in fetal DNA methylation.[77,78] Methylation of gene regions such as the promoter of the glucocorticoid receptor and the serotonin transporter has been observed in peripheral tissue samples from children born to women with antenatal depression.[79] Additional differential DNA methylation has been

observed in brain tissue. In fact, research has found that antenatal depression predicts methylation of infant NR3C1, a gene involved in binding and regulating cortisol response levels. Adaptive responses to the environment prior to and during pregnancy – including the dysregulation of the maternal stress response - can affect fetal development and disease susceptibility well into adulthood. Methylation of NR3C1 – for instance - impacts infant neurodevelopment including alteration of HPA stress reactivity during infancy,[87] which may have a lifelong impact on neurobehavioral and mental health outcomes.[88] It is further postulated that activation of the maternal stress response can result in reduced blood flow to the uterus and fetus.[89] Observed adverse outcomes associated with maternal stress and depression are highly variable; outcomes vary based on the timing of the stressor (e.g. preconception, first trimester), the intensity of the stressor, and whether it is chronic or acute.[90]

2.1.4.3.2.1 Size for gestational age as a proxy for chronic stress-related adverse fetal programing. Birthweight – and especially LBW – has long been considered as a proxy for exposure to adverse fetal conditions within the DOHaD framework.[91] Infant birthweight reflects both infant growth and infant length of gestation; for instance, LBW infants (<2,500g) could be premature (<37 weeks of gestation) and/or have experienced growth restriction in utero due to genetic or environmental factors. Both preterm birth and growth restriction have multiple underlying sociodemographic and medical risk factors, some of which overlap.[92] In fact, growth restriction is one pathway to preterm birth[93] and growth restriction is common for births before 37 weeks of gestation.[93] Both acute and chronic stress as well as maternal depression are associated with preterm birth and alterations to fetal growth.[19,94–96] However, others have found size for gestational age to be a more sensitive birth outcome to chronic and sustained socioeconomic factors than preterm birth; though spontaneous preterm births were more

sensitive to things like financial strain than medically indicated preterm births.[97]

Small for gestational age (SGA) – defined as infants with a birthweight below the 10th percentile for their gestational age – is frequently used as a proxy for fetal growth restriction, though it also includes infants who are constitutionally small.[98] Notably, both being born small and being born big are markers for poor health across the lifecourse.[21–24] As with fetal growth restriction, chronic stress is also associated with large for gestational age (LGA; birthweight above the 90th percentile for gestational age); as chronic stress and depression are robustly associated with obesity,[41,99] and maternal obesity is associated with LGA.[100,101] In fact, infants born to women with concurrent depression and obesity are at even greater risk of LGA relative to infants born to women with either condition alone.[20] As with stress exposure and experiences of depression, there are race/ethnic inequities in size for gestational age; Black infants are disproportionately born SGA and Hispanic infants are disproportionately born LGA.[102–104]

The bimodal risk profile of size for gestational age makes this birth outcome an important but understudied outcome to consider when evaluating policy level interventions. Interventions that target one but not the other may simply shift the entire size for gestational age distribution to the left or right, reducing inequities in one outcome at the expense of the other. In contrast, an ideal population-level intervention for size for gestational age would simultaneously increase size in the smallest infants while decreasing size in the largest infants, narrowing the distribution of size for gestational age and accomplishing the intervention goal of improving population health.[105]

2.1.5. Depression and disproportionately affected populations: Summary

Women - specifically reproductive-age women and minority women - are particularly vulnerable to depression in part due to chronic stressors associated with gender, race, and pregnancy status. The impact of gender, race, and pregnancy status are further

intersectional: prevalence of depression is greater in pregnant women than non-pregnant women – especially those with a history of previous depression - and women of color with depression are disproportionately more likely to experience adverse birth outcomes.[19,106–108] Importantly, many of the added stressors associated with belonging to any of the three subpopulations described above can be attributed to socioeconomic wellbeing, in particular a higher burden of poverty.

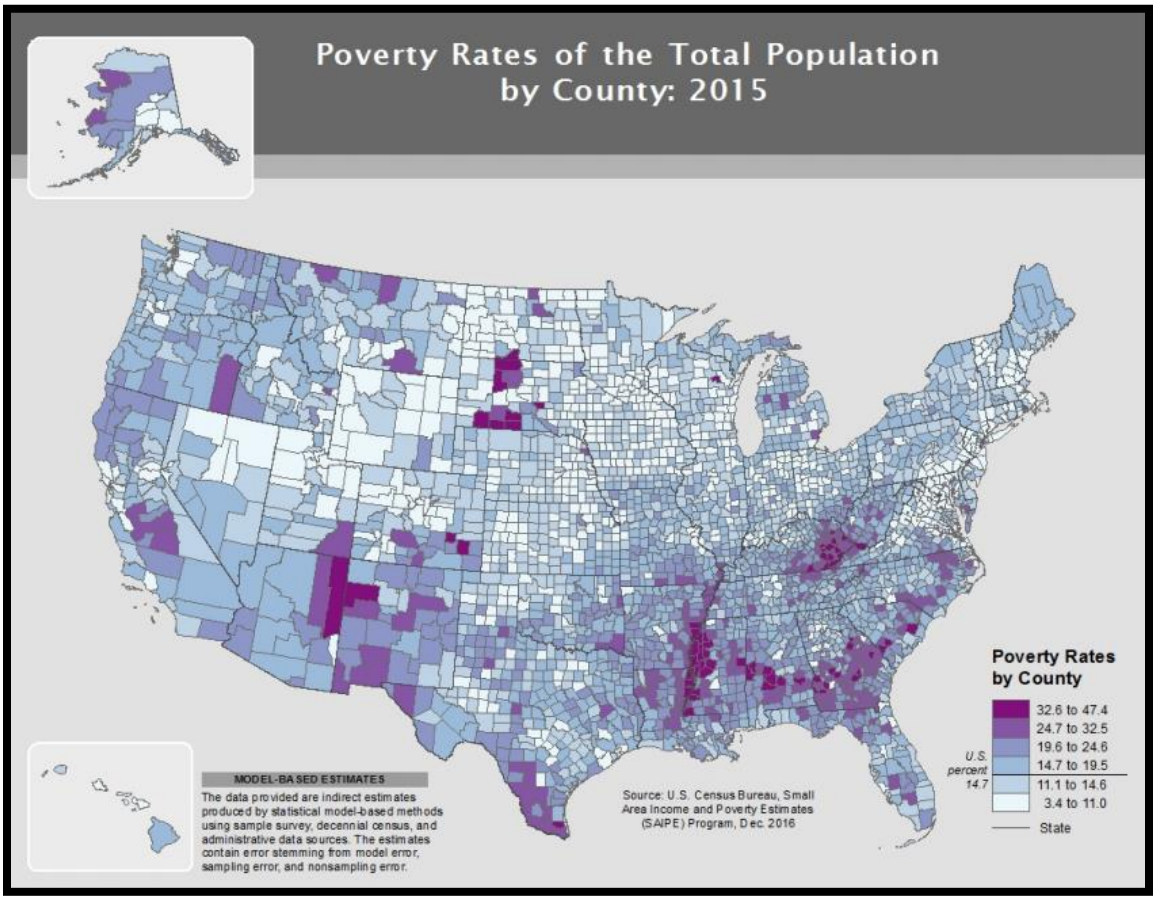
2.2. EXPOSURE – Precarious tipped service work and the subminimum wage. The exposures of interest for this dissertation are tipped service work and the state-level tipped worker subminimum wage. The following sections detail the rationale for investigating tipped service work and focusing on subminimum wage as a potential policy lever that could reduce volatility of earned income and subsequently the burden of poor mental health for the most vulnerable workers.

2.2.1. Poverty defined. In 2015, 45.7 million individuals in the US fell below the federal poverty line even after accounting for numerous government programs designed to assist low-income families and individuals (e.g. housing subsidies, supplemental nutrition programs).[109] The federal poverty level - as determined by the US Census Bureau - is based on the minimum amount of income needed to meet basic needs, which vary by family size and composition.[110] According to the current guidelines, the poverty threshold ranges from $12,486 per year for single individuals under age 65 to $46,400 per year for a single-parent household with eight or more children.[111] Importantly, these poverty metrics underestimate the problem; the federal poverty measure is outdated and does not adequately account for the necessary annual income to meet family budgets of housing, food, childcare, transportation, health care, taxes, and other necessities. For instance, the estimated annual cost for housing, food, childcare, transportation, health care, other necessities, and taxes for a single individual

with just one dependent child living in the Portland metro area is $68,449;[112] however, further exploring the insufficiency of the current classification of the federal poverty level is beyond the scope of this project.

14.7% of the US population lives below the federal poverty level with great heterogeneity based on geographic location; as much as 47.4% of the population in some counties are living in poverty (**Figure 2.2**). Moreover, the proportion of the population living below the federal poverty level is greater among women. Nonelderly women in the US are 40% more likely to be living below the federal poverty level relative to nonelderly men,[113] Black women are twice as likely as white women to live in poverty, and 36.5% of all female-headed families live in poverty.[114]

Figure 2.2. Proportion of the population living in poverty by county



2.2.2. Health impacts of poverty

2.2.2.1. Poverty is robustly associated with poor physical and mental health. Link and Phelan proposed that social factors - including socioeconomic factors - are fundamental causes of a multitude of diseases because they embody access to important resources, operate through numerous mechanisms, and ultimately maintain an association with disease even when intervening mechanisms change.[115] A robust relationship between socioeconomic status and mental health in particular has been increasingly apparent since early studies in New York neighborhoods more than fifty years ago.[116–119]. While social selection - whereby individuals predisposed to poor mental health experience downward mobility or inability to climb out of poverty - can co-occur,[120] the present project operates under the social causation hypothesis: that is, that poverty causes poor mental health, and that this relationship is mediated through chronic exposure to adversity and limited resources to bolster coping mechanisms.[120]

2.2.2.2. The compounding effects of gender, class, and race on the burden of depression in women. There are numerous correlates of depression symptomology that are similarly associated with poverty, including but not limited to gender, education, race, age, and occupation type.[9] The literature consistently highlights a high burden of depression in women living in poverty.[121–124] In a nationally representative sample of women, household income percentage of the federal poverty level was consistently associated with depression. For those women living below the poverty level, the 12-month prevalence of self-reported frequent depression was 25%.[1] Importantly, gender intersects with other marginalizing characteristics - such as race, educational attainment, and employment status - such that the number and combination of marginalized identities one has modifies their likelihood of having depression.[125] The additive effects of multiple marginalized identities is sometimes referred to as double or triple

jeopardy.[126] For instance, higher educational attainment attenuates prevalence of dysthymia - a milder but long-term form of depression - in women; however, high educational attainment appear to be more protective for White women than Black women.[127] Intersectionality also exists in regards to other poverty-related risk factors for poor mental health. Relative to men, women in poverty are more likely to experience concurrent risk factors for depression. For instance, low-income women are more likely to experience physical and/or sexual violence and subsequent post-traumatic stress disorder,[10] and to reside in disadvantaged neighborhoods.[128,129] Minority race increases this risk; for instance, having to frequently use public transportation is a risk factor for violent victimization for Black and Latina women but not for White women.[130] Thus the impact of poverty on risk of depression is heterogeneous across marginalized identities.

2.2.3. Absolute income and income volatility as causes of poor mental health.

Determination of an individual's relationship to the poverty threshold is based on their annual household income. Absolute annual income is associated with poor mental health,[8] operating through a variety of mechanisms.[9]. Higher income implies greater financial resources to manage health,[131,132] and higher-income jobs may be indicative of protective factors like social prestige and better working conditions.[9] Moreover, high income may be associated with lower financial strain. Financial strain and hardships, like difficulty paying bills or purchasing food, are robustly associated with depression.[4–7] Similarly, the experience of indebtedness is also associated with increased depression and suicidal ideation.[133] Importantly, interventions aimed at reducing the financial strain in low income women by provisions of childcare, transportation, and loan availability in a crisis are protective against depression.[134]

Irrespective of the amount of one's absolute income, income volatility - or unstable

income across weeks, months, or years - may also result in economic pressure and financial hardship and subsequently depression.[12,13] The U.S. Financial Diaries - a study that collected detailed financial data from 235 low- and moderate-income households over the course of a year - observed income fluctuations of more than 25% during at least five months of the year.[135] These fluctuations can occur more frequently for individuals who work in “precarious” occupations, which can include inconsistent wages, lack of health insurance, and no guarantee of steady full-time work or employer-supported pensions.[12,136] Unemployment, inconsistent work schedules,[137] significant wage changes, health problems, or disability all contribute to income volatility. Notably, fluctuations in income can be both more common and disruptive for low-income individuals, who often do not have the ability to buffer fluctuations in income through savings, credit, or liquidation of assets.[138] Moreover, public benefits like Temporary Assistance for Needy Families (TANF), unemployment, and the Supplemental Nutrition Assistance Program (SNAP) that are intended to reduce poverty are often inaccessible for workers with highly volatile income; income increases, even if temporary, can result in loss of benefits.[137] Alternative strategies to reduce income volatility - particularly among low- to middle-income households who are most vulnerable - are underexplored.

Thus income and income volatility are highly dependent on their occupation.[139] As such, individuals in occupations that entail low and/or highly volatile income are particularly vulnerable to poor mental health. Importantly, the at-risk groups of reproductive-age women and minority women are also the subpopulations most likely to work in precarious occupations.

2.2.4. Precarious work as a route to poverty and poor health. The overarching subject of this dissertation is the health impact of precarious work; that is, work that is poorly paid, insecure, and unprotected.[140]

2.2.4.1. Gender and occupation stratification into precarious work. Women make up 56% of all individuals employed in service occupations (relative to 47% of the total labor force).[141] Service occupations include: healthcare support occupations (87.7% women; e.g. medical assistants, home health aides), protective service occupations (22.3% women; e.g. firefighters, animal control workers), food preparation and serving related occupations (53.5% women; e.g. dishwashers, waiters and waitresses), building and grounds cleaning and maintenance occupations (40.1% women; e.g. janitors, maids), and personal care and service occupations (77.3% women; e.g. hairdressers, childcare workers).[142]

There is little dispute among scholars that there is gender segregation in the workforce.[143–147] Educational tracking begins early in the lifecourse; for instance, kindergarten teachers perceive girls as less proficient in math than their male counterparts, even when they receive the same objective scores on tests.[148] These subjective perceptions – further compounded by the child's socioeconomic status and other characteristics[149] – ultimately impact educational achievement. However, even among those placed in "lower" educational tracks, studies have found that vocational training disproportionately provides sustainable labor force skills to white men, while women and people of color tend to be placed in service sector vocational training and consequently similar jobs.[143] Importantly, many of these occupations are highly precarious, characterized by lack of continuity, low wages, lack of benefits and possibly greater risk of injury and ill health.[136] As such, women in these occupations experience disproportionately more income volatility.

2.2.4.2. Precarious work as a risk factor for stress and depression. Workers in the service industry experience considerable instability. Service workers are frequently subjected to "just-in-time" scheduling, and other employer-driven unpredictable last-

minute scheduling practices.[150,151] Moreover, individuals working in the service industry frequently lack access to health-promoting benefits such as insurance and paid leave.[3,152,153] In addition, service occupations are consistently the worst-paying occupation group. The 25 occupations with the lowest median hourly wage are all service occupations.[139] Individuals in service occupations represent 42.5% of all hourly wage workers earning the federal minimum wage and 78.1% of all hourly wage workers earning below the federal minimum wage.[154] Because of the previously described gender-based occupation stratification, women - especially reproductive-aged women with low educational attainment - are likely to be tracked into these low-paying occupations.

All of the characteristics described potentially impact mental health. Level of job control modifies the relationship between level of job demands and mental health.[155] The high demands of service work coupled with lack of control over one's schedule (among other elements of one's job) may have a negative effect on mental health.[156] Inconsistent work schedules are also indicated as the cause of income volatility in 40% of households;[137] income volatility as described previously is a risk factor for poor mental health.[12,13] Finally, because absolute income is associated with mental health as described above,[8] low wages may indicate high burden of financial strain, limited access to resources, and subsequently high burden of depression.

Importantly, among the 25 occupations with the lowest median hourly wage, 56% are food preparation and serving related occupations, and 44% are occupations where wages include tips from customers.[3,142] Tipping became a common practice for many service occupations during the Prohibition era; it was highly encouraged by proprietors of establishments that formerly sold alcohol, who were experiencing a loss in profit and

wanted to supplement the cost of employee wages.[157] To this day, tipped employees derive the majority of their income from customer-provided tips.[3] A report from the Economic Policy Institute suggests that tipped service work in particular is even more precarious than untipped service work,[3] and their data show these workers - 67% of whom are women - may make up a large proportion of the workforce earning below the minimum wage (**Table 2.1**).

Table 2.1. Wages and gender composition of predominantly tipped occupations ranked from lowest to highest median hourly wage

Occupation	# Employed	% Women	Wage Percentile	
			10th	50th
All workers, tipped and non-tipped occupations	127,063,149	48.3%	$8.45	$16.48
Predominantly tipped occupations				
Hosts and hostesses, restaurant, lounge, and coffee shop	283,677	85.4%	$6.87	$8.64
Waiters and waitresses	2,122,427	70.3%	$5.71	$9.93
Dining room, cafeteria attendants, and bartender helpers in hospitality industries	244,953	29.7%	$6.46	$8.79
Personal care and service workers, all other	73,854	48.5%	$7.18	$10.24
Barbers	59,002	23.6%	$5.93	$10.41
Miscellaneous personal appearance workers	227,634	82.5%	$7.24	$10.80
Hairdressers, hairstylists, and cosmetologists	483,312	94.1%	$7.10	$11.90
Bartenders	393,102	58.4%	$6.99	$12.02
Taxi drivers and chauffeurs	260,901	14.6%	$7.52	$11.95
Massage therapists	88,151	81.1%	$7.92	$14.22
Gaming service workers	106,252	48.4%	$7.93	$14.69
Total predominantly tipped workers	**4,343,264**	**66.6%**	**$6.49**	**$10.22**

Source: Analysis of Current Population Survey Outgoing Rotation Group microdata, pooled sample 2011–2013 by Allegretto and Cooper (2014)

2.2.4.3. Disparities in tipping practices. According to the Fair Labor Standard Act (FLSA) described further below, “Whether a tip is to be given, and its amount, are matters determined solely by the customer, who has the right to determine who shall be the recipient of the gratuity.” (29 C.F.R. § 531.52). Studies have found tipping practices to be strongly discriminatory. For instance, when delivering the same quality of

service,[158] white workers receive larger tips than Black workers[3] an observation that has been made among both restaurant servers[158] and taxi cab drivers[159] alike. While not the only determinant, this likely contributes to the fact that workers of color within the restaurant industry are twice as likely to live in poverty relative to their white coworkers.[160] Moreover, nationwide, women in tipped occupations earn 6% less per hour than men.[3] Part of this discrepancy is attributed to further gender-based occupational stratification; among tipped workers, women are much less likely than their male counterparts to work in fine dining establishments.[161] However, individual customer perceptions also play a substantial role. One study found that women only earned equivalent tips to men when their service was rated by the customer as “exceptional”, suggesting that women are being held to a higher standard, especially by male customers.[162] Another study found that male customers tipped more favorably if they found the female server attractive and/or she was wearing makeup.[163] Even a tipped employee’s schedule can dramatically impact their tips. For instance, in the restaurant industry, dinner is more lucrative than breakfast, weekends are more lucrative than weekdays, smaller parties tip a larger proportion of the bill than bigger parties, and having the section by the window is more lucrative than having the backroom.[158,164]

While establishment-based tactics like tip pooling, adding a fixed percentage gratuity to the bill, or raising menu prices and eliminating tipping practices can minimize or eliminate the impact of discretionary tipping within specific establishments,[165] these tactics are variably utilized and significant variation persists due to exogenous factors. There is marked variability in tipping from one establishment to the next and from one geographic location to the next, with one study finding tips received by tipped employees in rural areas were much lower than those received by tipped employees in urban

areas.[164,166] Moreover, the weather, season, and economic climate can all impact both patronage and customer generosity.[161,167,168] As such, income earned from tips is insecure, unpredictable, and thus highly volatile.

2.2.4.4. In the US, the FLSA dictates different hourly wage requirements for tipped and untipped employees. With the 1938 FLSA (C.F.R. § 202) the federal government established a minimum wage, overtime pay, record keeping, and youth employment standards affecting workers in the US. The cited intention of the FLSA was the elimination of "labor conditions detrimental to the maintenance of the minimum standards of living necessary for health, efficiency and well-being of workers."[169] Minimum wage standards represent an important contributor to one's economic security, with direct implications for income, income volatility, and experiences of financial strain as described above.

Under FLSA, covered nonexempt employees must be paid an hourly rate equal to or greater than the effective federal minimum wage, currently $7.25 (29 C.F.R. § 206). States have the ability to set higher state-level minimum wage standards, and in states with laws requiring higher standards, that standard applies.[170] FLSA does not mandate automatic minimum wage increases; each increase requires the congress to pass a bill that is subsequently signed in to law by the President of the US.[170]. The last minimum wage increase went into effect on July 24th, 2009[171] and, after accounting for inflation, is actually worth less than the minimum wage standard in 1968.[172] Importantly, there are various categories of workers who continue to be exempt from these minimum wage standards, and have standards of their own with implications that are not adequately addressed in the public health literature; this includes but is not limited to workers with disabilities, full-time students, workers aged 19 and younger, student learners (i.e.,

students in vocational training), and tipped employees.[170]

The original FLSA only afforded protections to about one-fifth of the US workforce.[173] In 1966, the FLSA was expanded to include wage protections for workers in restaurant, hotel, and other service occupations;[174] however, the employers of workers who customarily and regularly receive tips - deemed "tipped employees" (29 C.F.R. § 531.50) - continue to be permitted to use tips received from customers as "credit" toward their minimum wage expenses.[174] With the 1966 FLSA amendment, this tip credit was set such that is could not exceed 50% of the effective minimum wage; in other words, the reduced wage for tipped employees (hereafter referred to as the subminimum wage) could not be less than 50% of the effective minimum wage.[3] There have been subsequent amendments to the tip credit provisions of the FLSA (**Table 2.2).**[175]

Table 2.2. Evolution of the tip credit provisions of the FLSA

FLSA Amendment	Year	Minimum Wage at Effective Date	Employer Cash Wage for Tipped Workers (Subminimum Wage) in Current $	Employer Contribution to Tipped Worker Wages (Subminimum wage) as % of the Minimum Wage
P.L. 89-601	1967	$1.40	$0.70	50%
	1968	$1.60	$0.80	50%
P.L. 95-151	1978	$2.65	$1.32	50%
	1979	$2.90	$1.60	55%
	1980	$3.10	$1.86	60%
P.L. 101-157	1981	$3.35	$2.01	60%
	1990	$3.80	$2.09	55%
	1991	$4.25	$2.12	50%
P.L. 104-188	1996	$4.75	$2.13	45%
	1997	$5.15	$2.13	41%
P.L. 110-28	2007	$5.85	$2.13	36%
	2008	$6.55	$2.13	33%
	2009	$7.25	$2.13	29%

Source: CRS analysis of P.L. 89-601 (enacted 1966), P.L. 95-151 (enacted 1977), P.L. 101-157 (enacted 1989), P.L. 104-188 (enacted 1996), and P.L. 110-28 (enacted 2007).

The 1996 FLSA amendment removed this provision, and the subminimum wage is no longer required to remain a certain percentage of the full minimum wage[3] and has been stagnant at $2.13[176] since 1991.[3] Since then, the minimum wage has increased five times, while the subminimum wage has decreased in value from 50% to 29% of the minimum wage.[171]

Importantly, there are key legal requirements for employers regarding the subminimum wage.[177] The following requirements are those that were in effect prior to 2018, and were thus in effect when study data were collected. First, tipped workers who spend more than 20 percent of their workweek engaging in activities that are not directly generating tips - such as cleaning tables and making coffee - should legally be paid the full minimum wage. Second, employers are not permitted to deduct breakages, cash register shortages, and/or walk outs from the subminimum wages of their tipped employees. Third, under no circumstances should tips received by the tipped worker become property of the employer. In addition, while pooling tips with other tipped employees is acceptable, tipped workers should not be mandated to “tip out” to untipped employees (e.g. dishwashers, cooks). Finally, in instances where the summation of subminimum wage and the employees’ tips is not equal to or greater than the minimum wage, the employer should make up this difference. Notably, in 2018 two revisions were made to the legal requirements for tipped workers. First, as of March 2018 employers may establish a tip pool that includes untipped employees (e.g. back of house staff) if the employer does not take a tip credit (i.e. pays tipped workers the full minimum wage).[178] Second, as of November 2018, employers are no longer prohibited from paying subminimum wage when their tipped workers are engaged in activities that are not directly generating tips including time spent performing duties after the establishment closes (e.g. vacuuming).[179] The introduction of these policies is unsurprising given both

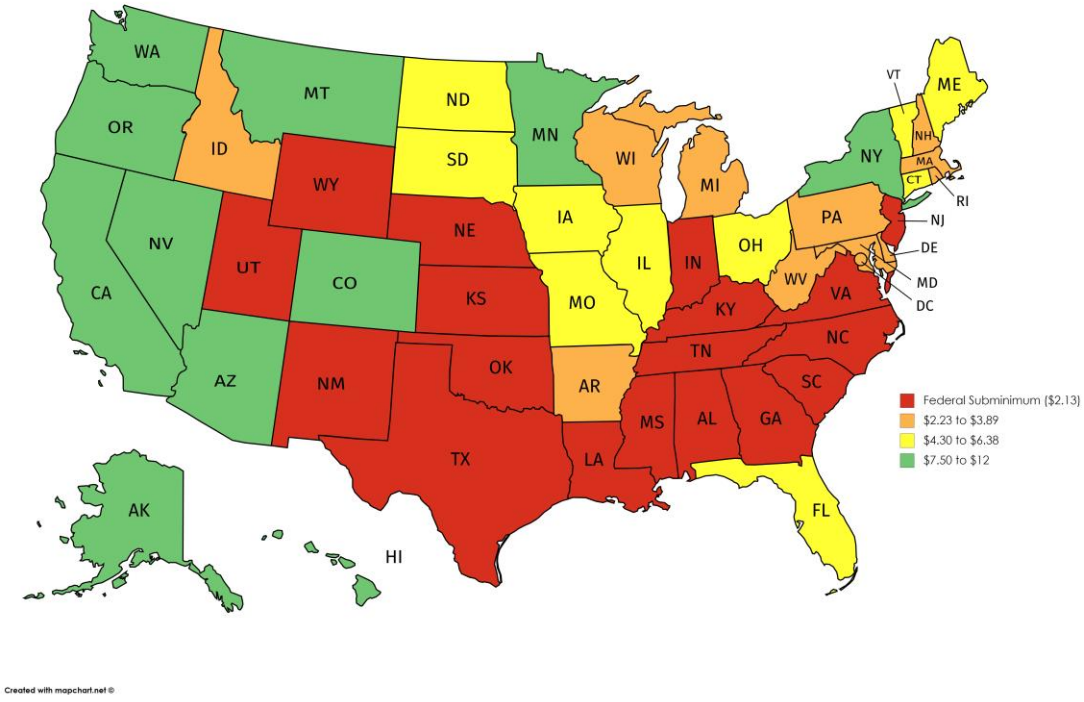
the current political climate and the tendency for tipped work-related revisions to the FLSA to favor business owners. While it is beyond the scope of this dissertation to investigate the impact of these recent revisions, I posit they will contribute to further diminishing the hourly wages of tipped workers.

2.2.4.4.1. Wage violations. Recent evaluations by unions and advocacy organizations have revealed substantial wage violations. Namely, tipped workers often earn less than the minimum wage,[180–182] and as many as 20-30% of employers illegally take tips from their tipped employees.[183] During the 2010-2012 compliance sweep conducted by the U.S. Department of Labor's Wage and Hour Division, 83.8% of the investigated 9,000 full-service restaurants had one or more violation including 1,170 tip credit infractions necessitating $5.5 million in back wages.[174] The number of violations is likely greatly underestimated. The onus of reporting discrepancies between collective wage earned and the effective minimum wage is on the employee, and tipped employees are often unaware that their employer must make up the difference if they do not meet minimum wage standards[3]. Moreover, there are deleterious power dynamics in play, as tipped employees must confront and demand payment from their supervisor, who has the power to give or take away the more lucrative shifts and section and/or potentially terminate their employment. As such, the average hourly wage for tipped employees is nearly 40% lower than the average hourly wage for all workers. Relative to untipped workers, tipped workers are twice as likely to live in poverty, with restaurant servers in particular three times as likely.[184]

Many states have either independently decided to increase and enforce the required employer contribution to tipped employees' wages, or require employers to pay all workers at least the minimum wage regardless of tip status (**Figure 2.3).**[160] However, currently one-third of the country still enforces the federal subminimum wage.[176]

Because of this diversity, we are able to see that while the proportion of non-tipped workers living below the poverty level does not vary much by state tipped-wage policies, higher state-level tipped wage policy appears to reduce the proportion of tipped workers below the federal poverty level, with 18% of restaurant servers living in poverty in states adhering to the federal subminimum and 10.2% in states that do not permit subminimum wage.[173] It is for this reason that many argue the current subminimum wage structure violates the human right to an adequate standard of living.

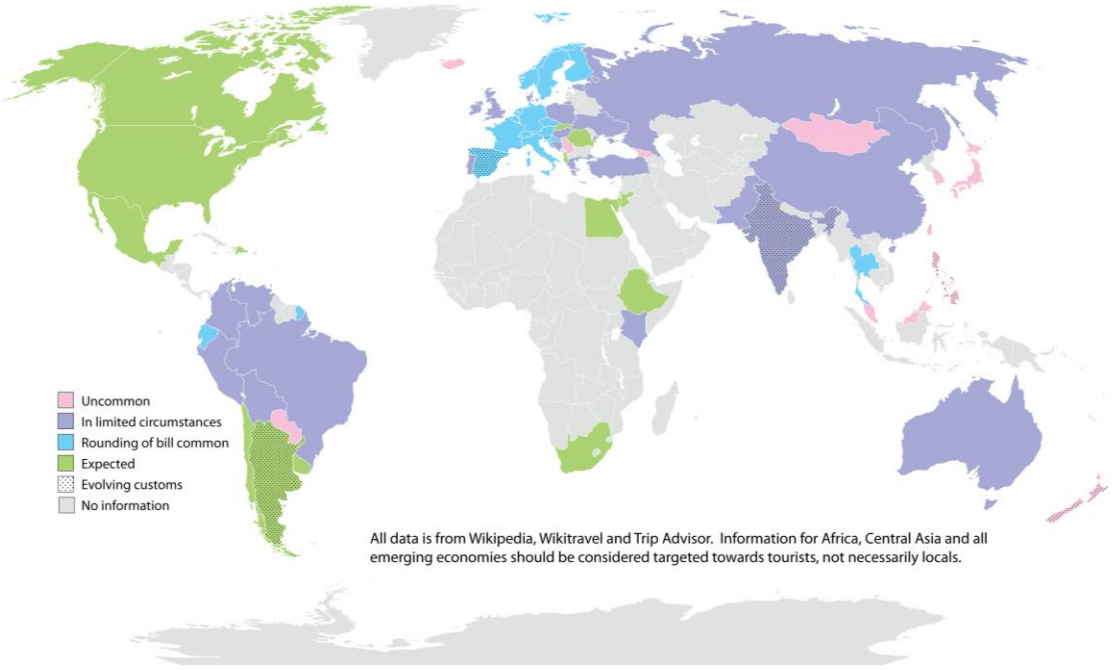
Figure 2.3. Subminimum wage for tipped workers by state as of January 2019



2.2.4.5. International variation exists in tipping practices, culture, and policy for the minimum wage of tipped workers. The present dissertation focuses on the US and review of other countries tipping policies was beyond the scope of this work. However, it is necessary to consider the tipping practices of other countries for rumination on generalizability of study findings. In addition, tipping practices in country of origin are yet another factor outside of the tipped worker's control that can shape a

customer's tipping practices. **Figure 2.4** displays a summary of tipping practices around the world.[185] While tipping culture in Mexico and Canada is similar to the US (some places in Canada even have a subminimum wage for tipped workers),[186] elsewhere tipping practices, culture, and policy can be very different. For instance, the UK had a subminimum wage for tipped workers, but eradicated it in a 2009 revision of the National Minimum Wage.[187] Similarly, countries like Australia welcome tips but pay their workers a living wage regardless[188] and others still find the tipping practice to be confusing or culturally offensive (like Japan).[189]

Figure 2.4. Tipping practices around the world



2.2.4.6. The limited research on subminimum wage suggests women in tipped work may be at greater risk of poor mental health. Below I summarize the existing literature on the health of the tipped workforce.

2.2.4.6.1. Emotional labor. A review of the literature found that customers tip significantly more when they experience a feeling of interpersonal connection with their

server,[190] suggesting tipped workers - especially those working in places where subminimum wage is much lower than the minimum wage - may have a higher burden of emotional labor and related consequences than even other service workers. Previous descriptive analyses have identified service workers as having the highest prevalence of depression and highlighted the role of interpersonal conflict and encounters with difficult people.[191,192] Another recent study found individuals working in lower-status public-facing occupations involving customer interaction, entertainment, sales, or other service oriented jobs had a higher burden of mental illness relative to other occupation types.[193]

Emotional labor is a key component of tipped work; tipped workers must carefully curate themselves in order to present organizationally desired emotions during interpersonal interaction with customers.[194,195] Previous research has highlighted how service professions that require frequent interactions with customers and mandatory expression or suppression of certain emotions can contribute to higher levels of stress.[196–200] In fact, studies have found that workers more skilled at interpersonal interactions experience greater job-related stress, as partially mediated through use of surface acting, such as pretending to feel happy in spite of extenuating life circumstances and/or the nature of the current interpersonal interaction.[201,202] Moreover, emotional labor mediates the relationship between customer incivility and emotional exhaustion,[203] implicating the further deleterious implications of exposure to customer aggression,[204] verbal abuse,[205] and sexual harassment.[194] This is further concerning given the reportedly high prevalence of violence, bullying, and sexual harassment observed worldwide in the hospitality industry.[206]

Simultaneously managing the emotional demands of customers as well as adhering to expectations for timeliness of service was one potential mechanism posited by authors

of a recent Canadian study driving gender differences in the burden of musculoskeletal issues in the food service industry.[207] Authors further noted heterogeneity in worker age by gender, with fewer older women in tipped occupations and suggest this could be due to a combination of their differential vulnerability to musculoskeletal issues (women disproportionately selecting out of this occupation as they age) and/or societal norms necessitating conventional attractiveness – and thus youthfulness – of female servers.

2.2.4.6.2. Sexual harassment. The reliance on customers for tips fuels an unequal power relationship, leaving women in tipped work vulnerable to sexual harassment and sexualized interactions with customers.[208] The Restaurant Opportunities Centers United reports that while sexual harassment occurs industry-wide, rates were highest in women in tipped occupations in states where subminimum wage is set to the federal $2.13.[209] Research has shown that women who experience more sexual harassment in the workplace report a greater number of depression symptoms than those who are not harassed, even after accounting for previous history.[210]

Zhu et al., (2011) observed tipped workers consumed more alcohol relative to untipped workers in the food service industry.[211] They hypothesized this may be due to having more “cash in hand” making tipped workers more apt to spend the cash on impulsive things like alcohol. However, it is known that depression mediates the relationship between sexual harassment – (and other stressors) and alcohol use in women.[212] As such, their observations could also be explained through the framework of depression and its risk factors. Notably, Zhu et al. utilized a nationally representative sample (1997 National Longitudinal Study of Youth) and did not examine how this effect may differ based on state-level policy. We hypothesize that, just as with sexual harassment and emotional labor, a relationship would persist but perhaps of less magnitude in states with more favorable wage policies.

2.2.4.6.3. Wage Instability. In a qualitative analysis of themes from social media use of the #LivingOffTips by tipped workers, researchers capture individuals' experiences with the insecurity of tipped labor.[213] Wage instability -- the experience of never knowing how much or how little one would take home each day of work, accompanied by personal stories of hardship and financial difficulty -- was a common theme.

Taken together, the literature supports the hypothesis that tipped workers are at increased risk of poor mental health, and that there are multiple mechanisms through which precarious tipped service work and state-level subminimum wage may impact women's mental health. Moreover, given the intersectionality of race, class, and gender as well as the impact of environmental factors on tipping behaviors, the impact of precarious tipped service work and state-level subminimum wage on depression is likely heterogeneous.

2.2.5. Existing evidence on the effects of wage policy on employment, income, and health. This section provides a summary of the existing literature investigating the impact of wage policy on employment, income, and health within the context of co-occurring policies.

2.2.5.1. The impact of wage policy on employment rates and earned income. Economists have been exploring the impact of minimum wage standards on employment and income for years. In regards to employment, higher labor costs prompted by increased minimum wage standards may force employers to increase their costs, downsize, and/or reduce the work hours of their employees. Alternatively, employment may be robust to increases in the minimum wage, as increased pay may result in increased purchasing of goods and services, creating higher demand and necessitating employment of more workers to meet that demand. The findings from studies examining the impact of increasing the minimum wage on employment are heterogeneous. In one

summary of the literature from the Congressional Budget Office (2014), it was estimated that increasing the federal minimum wage from $7.25 to $10.10 would result in 0.3% of the workforce losing their jobs. However, work from Card and Krueger actually found increased employment following increased wages,[214] and authors of a recent review determined that there would be little to no employment loss in response to modest increases in the minimum wage.[215]

Similarly, Allegretto and Nadler (2015) found that a 10% increase in the tipped wage had a small and insignificant impact on employment of tipped workers in full-service restaurants;[174] however, Even and Macpherson (2014) found that such an increase in subminimum wage would decrease employment.[216]

In contrast, all of the above studies are in agreement that wage increases increase earned income, with the caveat being that this is only for those individuals who are still employed. However, the potential benefit of an increased income is complicated. As discussed above, states with higher subminimum wage have a lower proportion of tipped workers living below the federal poverty level. The federal poverty level guidelines are used as eligibility criteria for many federal programs with specific income criteria that vary by state.[217] As such, small increases to wage standards may result in less net resources in some states. For example, in the state of Indiana, a single parent with two children loses access to SNAP as their income approaches $11 per hour and a $9000 childcare benefit as their income approaches $15 per hour.[218] Thus the potential impact of increasing the subminimum wage on the health of women and their children is likely heterogeneous in part due to other state-level factors such as potentially increasing the unemployment rate and failing to meet social welfare eligibility criteria.

2.2.5.2. Existing evidence on the implications of wage policy and health. While the effects of increasing the subminimum wage on health have yet to be examined, there is a burgeoning literature examining the health implications of various policies aimed at increasing the incomes of low-income and working class families.[219]There is an emerging literature on the substantial public health impact of an increase to the minimum wage in particular. Studies have projected that a $1 increase in the minimum wage would result in 5,000 fewer adolescent births[27] and 2,790 fewer low birth weight births[28] annually. Wehby et al. (2016) similarly observed healthier birth weights in response to minimum wage increases as well as evidence of an increase in prenatal care use and a decrease in smoking during pregnancy.[29] Others have observed that increasing minimum wage is associated with a reduction in unmet medical needs[131] and reduced depressive symptoms[25,220] and mental strain[221] in low wage workers. An assessment in New York City revealed that a $15 minimum wage could have averted as many as 2,800 to 5,500 all-cause premature deaths.[26] Conversely, others have found increases in minimum wage are associated with increased body weight[222] and an increase in the number of alcohol-related accidents involving teen drivers;[223] however, these results could not be replicated using other data sources.[224,225] In addition, the mechanisms of modification of health behaviors, leisure expenditures, and financial stress have been highlighted and evaluated as explanations for observed improvements in health in response to wage increases.[226]

Beyond increasing wage standards, two social policy levers that increase the income of workers are the Earned Income Tax Credit (EITC), a benefit for working people with low to moderate income, and Temporary Assistance for Needy Families (TANF), temporary financial assistance for pregnant women and families with one or more dependent

children. The receipt and amount of EITC provided are similarly associated with decreased maternal smoking, use of prenatal care, healthier birth weight, likelihood of going to term, likelihood of breast feeding, healthier children, and reduced depression symptoms in mothers.[227] In the same review of the literature, TANF tended to be associated with more adverse effects on health, with one hypothesis being that this observation could be due to mothers being unable to make the transition from welfare to work and then losing access to their social safety net due to TANF time limits.

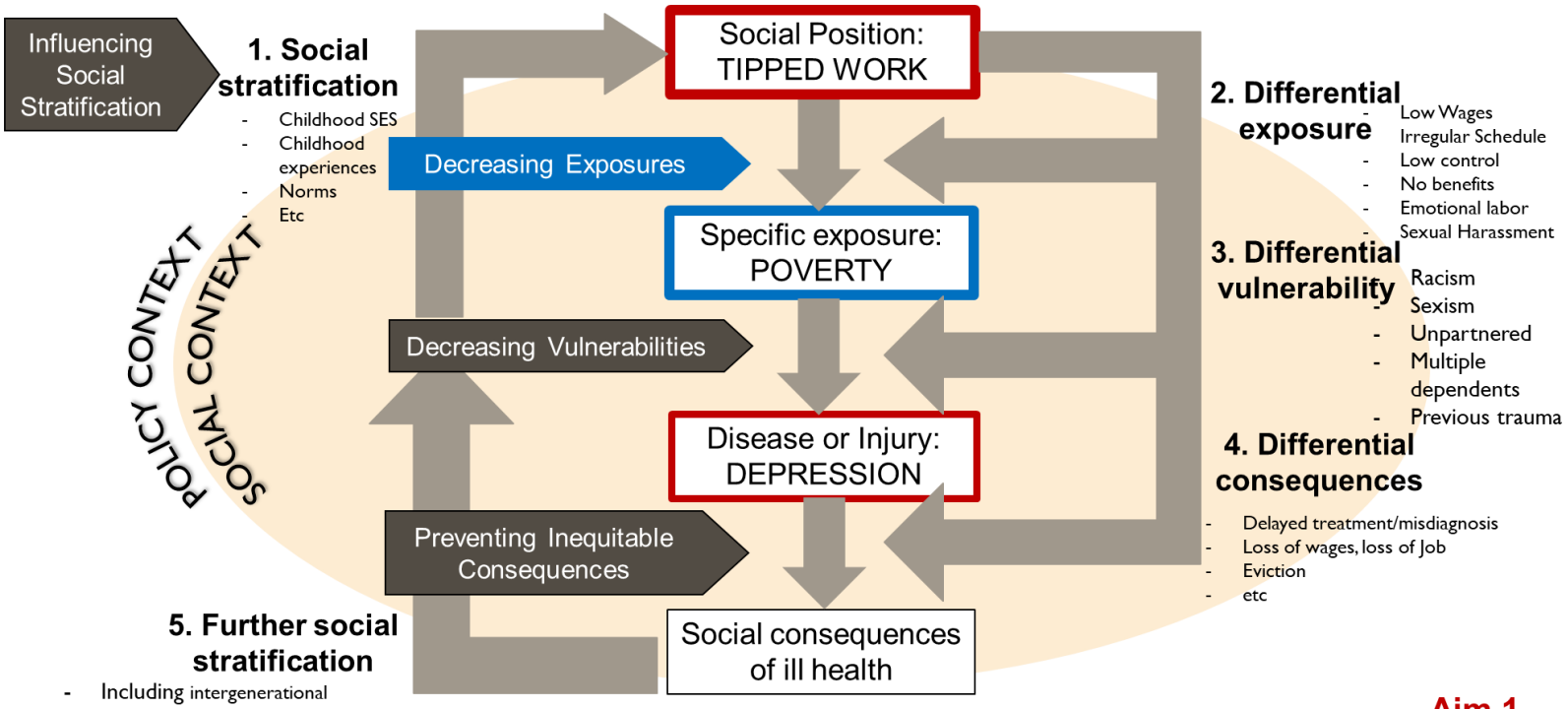
This literature informs our hypothesis that increases in subminimum wage will be associated with improved health of women and their children. Moreover, these time-variant social policy initiatives are important confounders and effect modifiers to consider in our analyses.

2.3. Contributions of this dissertation to the literature. The work that follows represents the first investigation of the potential consequences of tipped service work for the mental health of reproductive-aged women as well as one potential intervention: raising the subminimum wage.

The overarching conceptual framework for this dissertation is the Diderichsen and Hallqvist's framework for elucidating the pathways through which social context affects health outcomes.[228] **Figure 2.5** displays an adaptation of this framework to the study of the health implications of tipped service work as informed by the literature.

I posit that – through aspects like childhood socioeconomic status, childhood experiences, and norms – social context shapes educational quality, attainment, and occupational opportunities and preferences leading to social stratification into different occupations. These different occupations lend individuals to experience different exposures – such as differential exposure to poverty from low and/or unpredictable

Figure 2.5. Adaption of Diderichsen and Hallqvist's 1998 model of the social production of disease



wages and poverty-related stress – that are risk factors for poor health. Social context and subsequent social stratification further engenders both differential vulnerability to these exposures (e.g. an already dysregulated stress response system from cumulative experiences of sexism) as well as differential consequences (e.g. delayed treatment or misdiagnosis, job loss, eviction). Finally, I posit that these differential consequences engender further social stratification both within one's own lifecourse and intergenerationally. Within this framework, there are four opportunities for intervention, namely by influencing social stratification (e.g. influencing educational tracking), decreasing exposures (e.g. policies that reduce poverty, address scheduling irregularities), decreasing vulnerabilities, and/or preventing inequitable consequences.

In **Aim 1** I examined the overall association between occupation type (tipped service, untipped service, non-service) and depression; knowledge of social stratification into occupation guides my analytic sample development and analysis strategy. In **Aims 2** and **3** I target differential exposure to poverty and investigate whether increasing the tipped worker subminimum wage could reduce poverty-related antenatal stress and promote healthier birthweight in infants, especially for those hypothesized to be differentially vulnerable. My contributions to the literature are as follows:

Ch.	***Purpose***	***Contribution to new knowledge***
3	Determine if reproductive-aged women working in tipped service experience greater odds of depression relative to similar women in: (1a) non-service and (1b) untipped service occupations.	Findings fill in a major gap in the evidence base with respect to the burden of depression in the tipped workforce and identify some differential workplace exposures/potential opportunities for intervention.
4	Determine if increases in state-level subminimum wage are associated with reduced cumulative poverty-related antenatal stress in women.	Findings provide an objective evaluation of the potential impact of changing the tipped worker subminimum wage on experiences of poverty-related stress during a particularly vulnerable life stage, highlight potential for differential effects, and provide preliminary evidence for how changes to subminimum wage policy should be implemented
5	Determine if increases in state-level subminimum wage are associated with healthier birthweight in infants.	Findings provide an objective evaluation of the potential impact of changing the tipped worker subminimum wage on infant size for gestational age and provide preliminary evidence for how changes to subminimum wage policy should be implemented to promote healthier birthweight in infants.

CHAPTER 3: Associations of Tipped and Untipped Service Work with Poor Mental Health in a Nationally Representative Cohort of Adolescents Followed into Adulthood

Sarah B. Andrea, Lynne C. Messer, Miguel Marino, and Janne Boone-Heinonen

Author Contributions: SBA conceived of the study, performed statistical analysis, and drafted the manuscripts. MM assisted with statistical analysis and interpretation of statistical findings and critically reviewed the manuscript. LCM assisted with the interpretation of study findings and critically reviewed the manuscript. JBH assisted with and supervised all aspects of the study and critically reviewed the manuscript. Components of this work were presented by Sarah B. Andrea at the American Heart Association EPI Lifestyle Scientific Sessions on March 9th, 2017 and the Society for Epidemiologic Research Annual Meeting on June 22nd, 2017.

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3.1 ABSTRACT

Precarious work is concentrated in the service industry in the United States and is a risk factor for poor mental health. Service occupations in which workers receive tips are potentially more precarious due to unstable schedule, income, and lack of benefits. We tested hypotheses that individuals working in tipped service occupations have greater odds of experiencing poor mental health (self-reported depression, sleep problems, and/or greater perceived stress) relative to individuals in untipped service and non-service occupations using cross-sectional data from the National Longitudinal study of Adolescent to Adult Health dataset (Wave IV:2007-2008; age 24-33 years). To improve comparability of occupation types, propensity-scores were computed as a function of childhood factors, then used to construct a sample of 2,815 women and 2,586 men. In gender-stratified multivariable regression, women in tipped service had greater odds of reporting depression diagnosis or symptoms relative to women in non-service work (Odds Ratio:1.61; 95% Confidence Interval:1.11,2.34). Associations of similar magnitude for sleep problems and perceived stress were observed among women, but were not significant; all associations were close to the null among men. Further research is necessary to understand the factors that underlie differences in poor mental health in tipped and untipped service versus non-service workers.

3.2 INTRODUCTION

An individual's occupation can lead to differential exposure to physical, psychosocial, and environmental factors with the potential to influence their health.[229] Individuals in service occupations – especially tipped service– may be particularly vulnerable; however, the potential health effects of these occupations are understudied.

Service work is precarious,[230] characterized by lack of control over hours worked and shift,[150,151] insufficient benefits,[3,152,153] and lower wages. Service workers represent 42.5% of workers earning the federal minimum wage and 78.1% of workers earning less than minimum wage.[154] Tipped work may be particularly precarious service work for several reasons. First, the normalization of tipping in certain service occupations in the United States (US) has led to differential minimum wage standards; workers in tipped occupations can be paid a wage 71% lower than the federal minimum wage [176] with the expectation that highly unpredictable and inequitable tips from customers will make up the difference.[3] On average, tipped workers are nearly twice as likely to live in poverty relative to untipped workers.[3] Second, tipped workers are disproportionately exposed to last minute scheduling practices[150,152] and insufficient provision of benefits.[3] Third, workers in tipped and untipped service occupations must frequently express or suppress certain emotions during interactions with customers[196–200] and manage sexualized or hostile customer behavior.[208]

These aspects of tipped service work have direct consequences, such as physical harm, and indirect consequences for health, such as psychosocial stress, with the latter representing an important determinant of mental health.[231,232] A 2007 report from the National Survey on Drug Use and Health revealed the 12-month prevalence of depression among workers aged 18-64 was highest among those in personal care and

service (10.8%) and food preparation and serving related occupations (10.3%).[192] Similarly, the highest prevalences of short sleep duration and other sleep disturbances have been observed within service industry occupation categories[233] and financially precarious employment in general.[234] However, the potential health implications of tipped work have been minimally assessed and are limited to substance use.[211]

In light of the dearth of research on the potential impact of working in a tipped service occupation on health, our objective was to test the hypotheses that (a) individuals in service occupations (both tipped and untipped) have greater odds of experiencing depression, sleep problems, and/or stress relative to their non-service counterparts; and (b) individuals in tipped service occupations are particularly vulnerable to these mental health outcomes.

3.3 METHODS

Participants

This study utilizes data from the National Longitudinal Study of Adolescent to Adult Health (*Add Health)*, a nationally representative cohort of US adolescents followed >14 years into adulthood.[235] *Add Health* utilized a stratified, school-based, clustered sampling design to ensure data were representative of the US adolescent school population. Detailed information on the *Add Health* study design and procedures are described elsewhere.[235] Briefly, a core subset of respondents and parents were randomly selected from within school and gender strata to participate in in-home interviews by trained interviewers.[236] Seventy-six percent of baseline respondents (n=15,701/20,745) completed Wave IV, when participants were aged 24-33. This study was exempted by our Institutional Review Board.

Variables and Measurement

Exposure: Occupation type (non-service, tipped service, untipped service). Occupation type was classified from responses to two Wave IV questions about current or recent occupation. The classification of *service* was assigned to participants if their response to the question, "When you see the list of categories, please tell me which best describes what you (do/did) at your (current/most recent) job?" was consistent with a service occupation according to the US Bureau of Labor Statistics industry classification system (e.g., "food preparation and serving occupation"; **Appendix Table A2.1**;[237]). *Non-service* was assigned to participants reporting other occupation types. *Tipped service* was assigned to respondents classified as working in service occupations if their response to the question, "Out of these categories, which one best describes this job?" was consistent with a predominantly tipped occupation according to the Economic Policy Institute (e.g., "waiters and waitresses"; **Appendix Table A2.1**;[3]). *Untipped service* was assigned to respondents in service occupations reporting any other occupation.

Outcomes. Wave IV constructed variables developed by *Add Health*[238] were utilized as measures of the three mental health outcomes:

Depression or depressive symptoms (yes/no) were defined as self-reported diagnosis of depression and/or depressive symptoms within the past 7 days reported on the modified version of the Columbia Center for Epidemiological Studies Depression Scale-10.

Sleep problems (yes/no) included self-reported difficulty falling or staying asleep and/or symptoms of sleep apnea over the past four weeks.

Perceived Stress was a three-level ordinal variable constructed from tertiles of the Cohen's Perceived Stress Scale score (0-3, 4-6, and 7-16). There are no broadly applicable score cut-offs and others advise within sample comparisons.[239]

Statistical Analysis

Analyses were conducted in Stata/IC 14.2 (StataCorp LP, College Station, Texas), incorporating *Add Health* survey weights and sample design parameters to account for clustered sampling, attrition, and oversampling, thus approximating the target population of US adolescents in grades 7-12 in 1994.

The analytic sample was restricted to respondents who participated in Waves I-IV and had an *Add Health* sampling weight for analysis (N=9,421), reported a current or recent job in Wave IV (N=9,205) and exhibited complete exposure and outcome data (N=9,140). Participants with missing covariates were included; multiple imputation methods were applied as described below. *Add Health* sampling weights incorporate a non-response adjustment for nonparticipation in one or more wave of in-home interviews.[240] The analytic sample thus contained 9,140 respondents (N=4,996 women and N=4,144 men) prior to application of propensity score methods.

Propensity Score Methods. Our analytic approach addressed two methodological challenges related to occupation stratification. First, there is gender-based stratification into occupational categories and specific occupations within those categories:[241] 56.6% of all service workers[142] and 67% of tipped workers are women.[3] Second, additional non-random assignment to occupational category resulting from social selection based on sociodemographic characteristics and other predisposing life experiences[242] may impact health. Therefore, we stratified all analyses by gender and utilized gender-specific propensity scores (PS) to address residual structural confounding present in occupation type assignment. For each gender, a single set of PSs were generated to be used for all outcome models, and were developed using variables for participant sociodemographics, parental characteristics, and childhood adverse experiences, behaviors, and health (**Appendix 2.A.**) selected using our conceptual framework

(**Appendix Figure A2.1**). **Appendix 2.B** describes the process used to calculate PSs, including the application of multiple imputation to address missingness of variables pertinent to PS development. Multinomial logistic regression was used to model occupation type as a function of these variables and predicted probabilities for each occupation type were computed (**Appendix 2.B**). PSs first served as decision aids for visually-guided restriction of the analytic sample to satisfy the positivity assumption and provide support for exchangeability (**Appendix 2.C**;[243]).

Multivariable Analysis of Outcomes. Multivariable analyses were conducted with the PS-restricted sample. Logistic regression was employed for binary outcomes (depression, sleep problems) and ordinal logistic regression was employed for the ordered 3-level categorical outcome (perceived stress), producing odds ratios. Though prevalences of study outcomes were high (>10%), it was not possible to estimate relative risk due to model complexity with survey design parameters, multiple imputation, and inclusion of an ordinal outcome

Within the PS-restricted sample, PS regression adjustment was used in multivariable analyses to achieve models that were parsimonious and adequately adjusted (**Appendix 2.D**). In addition to PS regression adjustment, variables that remained unbalanced after sample restriction were included in our models for residual confounding adjustment.

Sensitivity Analyses. We conducted three sensitivity analyses. First, the prevalence of childhood depression is disproportionately higher among individuals in service occupations and previous depression is a strong predictor of future depression.[244] Therefore, to further account for the social selection of individuals with poor mental health into service occupations, we restricted analyses to respondents with no prior reported depression (Wave II and III Center for Epidemiological Studies Depression Scale scores ≤ 3). Similarly, we restricted assessment of the association between

occupation type and sleep problems to respondents who reported never having difficulty falling or staying asleep or having difficulty “just a few times” in childhood (Wave II). Measures of perceived stress in childhood were unavailable. Third, to examine the potential contributions of precarious work beyond the effects of underemployment,[245] all outcomes were assessed with data restricted to those working full-time (≥35 hours/week).

3.4 RESULTS

Selected characteristics of 4,996 women and 4,144 men who reported a current or recent job during their Wave IV interview are presented in **Tables 3.1** and **3.2**, respectively. Participants in the full analytic sample were, on average, 28 years old at Wave IV (data not shown). Prior to PS-based sample restriction, women in service occupations tended to experience more adversity in early-life while women in non-service occupations were more advantaged. For instance, parental income and educational attainment were highest for women in non-service (mean income: $49,400; 36.1% college graduates) and lowest in untipped service occupations (mean income: $39,500; 19.4% college graduates). In contrast, parental incarceration was lowest among women in non-service (14.0%) and highest among untipped service (23.8%) occupations. This trend was not as prominent in men. Among both women and men, high educational attainment was most common among individuals in non-service occupations. At the Wave IV interview, women reported higher depression prevalence (across all occupation types: 25.6% in women vs. 13.5% in men).

PS distributions revealed 659 individuals with PSs in regions where not all exposure levels were represented; an additional 3,080 individuals were below the 5th or above the 95th percentile of one or more PS distribution (**Appendix Figures 2.2.A-C, 2.3.A-C)**. The PS-restricted analytic sample was thus reduced to 2,815 women and 2,586 men

Table 3.1. Select Characteristics[a] in Women Who Reported a Current or Recent Job During the Wave IV Interview, National Longitudinal Study of Adolescent Health, 1994-2008

Variables	Non-Service, %		Untipped Service, %		Tipped Service, %	
	Full Sample (N=3,751)	PS-Restricted Sample (N=1,990)	Full Sample (N=931)	PS-Restricted Sample (N=614)	Full Sample (N=314)	PS-Restricted Sample (N=211)
			Sociodemographic Characteristics			
Race						
White	71.7	74.7	66.6	67.0	80.5	81.1
Black	14.1	11.5	21.0	18.3	7.8	8.1
Other	14.2	13.8	12.4	14.7	11.8	10.8
Hispanic Ethnicity	12.3	14.2	10.4	13.4	7.6	9.9
Parent's Education (Wave I)						
<High School Graduate	8.9	8.6	16.6	11.6	9.6	6.1
High School Graduate	26.1	32.6	34.6	37.9	29.7	28.3
Some College or Vocational Training	28.8	34.1	29.3	30.4	35.0	33.8
College Graduate	36.1	24.7	19.4	20.0	25.7	31.7
Parent's Income (in $1,000)[b]	49.4 (2.4)	43.1 (1.9)	39.5 (2.7)	38.8 (2.3)	42.6 (2.4)	42.7 (2.7)
Parental Incarceration	14.0	14.1	23.8	18.9	18.2	17.6
Highest Level of Education						
<High School Graduate	5.1	3.5	12.4	5.5	8.6	7.1
High School Graduate	12.3	19.4	16.3	20.4	16.8	17.0
Some College or Vocational Training	39.7	56.3	57.3	68.1	62.9	67.5
College Graduate	42.9	20.8	14.0	6.0	11.7	8.4
Household Income (Wave IV; in $1,000)[b]	63.8 (1.3)	61.3 (1.4)	45.8 (1.6)	46.5 (1.9)	50.5 (2.8)	48.5 (3.1)
			Mental Health Outcomes (Wave IV)			
Depression	22.8	24.6	31.7	32.1	37.0	37.8
Sleep Problems	9.5	11.4	16.9	18.2	13.8	16.6
Cohen Perceived Stress Score Tertiles						
Low (0-3)	36.1	33.3	29.0	30.0	22.8	24.3
Medium (4-6)	36.7	37.2	31.8	32.2	38.1	37.3
High (7-18)	27.1	29.5	39.2	37.8	39.0	38.4

[a]Percentages, means, and standard errors are calculated by accounting for survey weights, strata, and clusters.
[b]Values are expressed as mean (standard error)

Table 3.2. Select Characteristics[a] in Men Who Reported a Current or Recent Job During the Wave IV Interview, National Longitudinal Study of Adolescent Health, 1994-2008

Variables	Non-Service, %		Untipped Service, %		Tipped Service, %	
	Full Sample (N=3,446)	PS-Restricted Sample (N=2,145)	Full Sample (N=586)	PS-Restricted Sample (N=372)	Full Sample (N=112)	PS-Restricted Sample (N=69)
	Sociodemographic Characteristics					
Race						
White	71.9	75.1	64.8	71.7	66.5	70.7
Black	12.5	11.4	22.7	16.5	15.6	11.3
Other	15.6	13.5	12.5	11.8	17.8	18
Hispanic Ethnicity	12.7	11.0	10.7	9.0	7.0	5.3
Parent's Education (Wave I)						
<High School Graduate	10.0	8.0	13.8	8.4	8.4	5.0
High School Graduate	25.3	26.8	26.4	27.5	18.6	22.3
Some College or Vocational Training	31.4	32.9	30.5	33.9	36.7	35.6
College Graduate	33.7	32.3	29.4	30.2	36.3	37.1
Parent's Income (in $1,000)[b]	46.5 (2.1)	44.2 (1.7)	40.9 (2.5)	41.8 (2.3)	44.7 (3.5)	45.1 (4.5)
Parental Incarceration	17.2	17.6	15.1	14.3	17.8	13.2
Highest Level of Education						
<High School Graduate	10.4	5.0	12.1	9.0	3.3	0.0
High School Graduate	19.6	26.0	23.0	23.8	17.1	22.5
Some College or Vocational Training	38.5	49.5	48.9	55.9	63.7	74.9
College Graduate	31.4	19.5	16.1	11.4	16.3	2.5
Household Income (Wave IV; in $1,000)[b]	65.8 (1.2)	64.6 (1.3)	55.0 (2.6)	53.8 (2.7)	54.9 (4.1)	60.6 (5.6)
	Mental Health Outcomes (Wave IV)					
Depression	13.0	12.4	16.1	14.9	15.7	10.8
Sleep Problems	11.4	11.1	11.5	10.3	10.7	14.7
Cohen Perceived Stress Score Tertiles						
Low (0-3)	39.8	38.3	40.4	41.0	29.9	29.5
Medium (4-6)	37.5	38.8	30.1	29.0	40.6	45.3
High (7-18)	22.6	22.9	29.5	30.0	29.5	25.2

[a]Percentages, means, and standard errors are calculated by accounting for survey weights, strata, and clusters.
[b]Values are expressed as mean (standard error)

(**Appendix 2.E**). Compared to the full sample, women in the PS-restricted sample (**Table 3.1)** had parents with lower educational attainment (across all occupation types: 24.2% graduated college in PS-restricted sample vs. 32.1% in full sample) and household incomes (across all occupation types: $42,000 vs. $47,000), and had lower educational attainment themselves (across all occupation types 16.4% graduated college vs. 34.9%). Men in the PS-restricted sample similarly had lower educational attainment (**Table 3.2**). The following variables remained unbalanced following analytic sample restriction and were included as covariates in the multivariable models: participant educational attainment (for women and men), race (women only), and parental educational attainment (women only).

Occupation Characteristics in the PS-Restricted Sample. The top four major occupation categories were: sales and related, office and administrative support, food preparation and serving related, and construction and extraction occupations (**Appendix Table A2.3**); 60% of tipped workers were waiters, waitresses and bartenders (**Appendix Table A2.4)**. Job characteristics, such as shift type and access to paid leave varied by broad occupation type (e.g. non-service, untipped service, tipped service; **Appendix Table A2.5**).

Multivariable Models. Women in tipped service work exhibited 61% higher odds of reporting depression diagnoses or symptoms relative to women in non-service work (95% Confidence Interval: 1.11,2.34; **Table 3.3**). The association between untipped service work (versus non-service work) and reported depression diagnosis or symptoms was weaker and not significant (Odds ratio: 1.25; 95% Confidence Interval: 0.93,1.68) Associations for sleep problems and higher perceived stress tertile were not significant, but of similar magnitude and direction. While not significant, associations with depression, sleep problems, and perceived stress were all of greater magnitude for

women in tipped relative to untipped occupations in women. Men exhibited an association similar to that seen in women for perceived stress, though it was weaker and not statistically significant.

Table 3.3. Mental Health Outcomes Regressed on Employment Category in Women and Men who Reported a Current or Recent Job During the Wave IV interview, National Longitudinal Study of Adolescent Health, 1994-2008

Gender and Occupation Type	Depression		Sleep Problems		Higher Perceived Stress Tertile	
	OR	95% CI	OR	95% CI	OR	95% CI
Women[a]						
Non-Service	1.00		1.00		1.00	
Untipped Service	1.25	0.93, 1.68	1.38	0.94, 2.03	1.13	0.88, 1.44
Tipped Service	1.61	1.11, 2.34	1.49	0.98, 2.24	1.32	0.95, 1.84
Men[b]						
Non-Service	1.00		1.00		1.00	
Untipped Service	1.23	0.81, 1.88	0.86	0.50, 1.49	1.10	0.78, 1.55
Tipped Service	0.82	0.29, 2.31	1.26	0.50, 3.22	1.24	0.73, 2.11

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test; BMI, Body Mass Index; CES-D, Center for Epidemiologic Studies Depression Scale; CI, Confidence Interval; OR, Odds Ratio; PS, Propensity Score; US, United States

[a]PS-Restricted Sample (N=2,815): Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS, race, parental educational attainment, and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

[b]PS-Restricted Sample (N=2,586): Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

Sensitivity Analyses. Associations were stronger in samples restricted to women with no previous history of depression (untipped odds ratio: 1.60, tipped odds ratio: 2.98; **Table 3.4**). Similarly, upon restriction to women with no previous sleep problems, women in untipped service occupations had 72% higher odds of reporting sleep problems relative to women in non-service occupations. Stronger associations for

Table 3.4. Mental Health Outcomes Regressed on Employment Category in Women and Men who Reported a Current or Recent Job During the Wave IV interview: Sensitivity Analyses, National Longitudinal Study of Adolescent Health, 1994-2008

Sensitivity Analysis Subgroup and Occupation Type	Women[a]						Men[b]					
	Depression		Sleep Problems		Higher Perceived Stress Tertile		Depression		Sleep Problems		Higher Perceived Stress Tertile	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
No Previous Depression[c]												
Non-Service	1.00						1.00					
Untipped Service	1.60	1.04, 2.46					1.00	0.58, 1.71				
Tipped Service	2.98	1.55, 5.70[d]					1.33	0.40, 4.44				
No Previous Sleep Problems[e]												
Non-Service			1.00						1.00			
Untipped Service			1.72	1.12, 2.66					0.73	0.39, 1.35		
Tipped Service			1.42	0.75, 2.71					1.12	0.43, 2.88		
Full-Time Workers[f]												
Non-Service	1.00		1.00		1.00		1.00		1.00		1.00	
Untipped Service	1.35	0.96, 1.90	1.38	0.84, 2.27	1.03	0.76, 1.39	1.37	0.87, 2.16	0.84	0.47, 1.50	1.12	0.77, 1.63
Tipped Service	1.49	0.91, 2.44	1.56	0.91, 2.67	1.12	0.70, 1.80	1.52	0.50, 4.62	1.61	0.51, 5.07	1.41	0.67, 2.93

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test; BMI, Body Mass Index; CES-D, Center for Epidemiologic Studies Depression Scale; CI, Confidence Interval; OR, Odds Ratio; PS, Propensity Score; US, United States

[a]Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS, race, parental educational attainment, and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

[b]Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

[c]No previous depression defined as childhood (Waves I and II) max CES-D score ≤ 3; N=1,223 Women & 1,552 Men

[d]Tipped service workers significantly different relative to untipped service workers

[e]No previous sleep problems defined as either never having difficulty falling or staying asleep or having difficulty “just a few times” during childhood (Wave II); N=916 Women & 997 Men

[f]Full time defined as 35 or more hours per week; N=2,209 Women & 2,338 Men

depression or sleep problems were not observed in men. Associations for women and men were similar, but statistically non-significant, following sample restriction to full-time workers. Estimates obtained using the full analytic sample with logistic regression covariate adjustment were comparable in direction and magnitude (**Appendix Table A2.6**)

3.5 DISCUSSION

This study investigated the association between occupation type and three adverse mental health outcomes within a nationally representative cohort of adolescents followed into adulthood. We observed cross-sectional associations between working in service occupations and poor mental health outcomes in women and men. While only one of the examined associations was statistically significant – women in tipped service work had greater odds of reporting depression relative to women in non-tipped work – the magnitudes of associations were consistently highest among women for tipped service occupations. In men, associations were weaker and not statistically significant, and this was confirmed in sensitivity analyses.

Our observation that service work was positively associated with depression is consistent with previous analyses that identified workers in the service industry as having the highest prevalence of depression and highlighted the role of interpersonal conflict and encounters with difficult people.[191,192] Observed associations with adverse mental health outcomes may further reflect the precarious nature of service work, which often entails lack of access to health-promoting benefits,[3,152,153] low wages,[139] and last minute scheduling practices.[150,152] This observation is also consistent with research in hotel employees, a subset of service workers that includes tipped and untipped workers in which job-related factors like low control, high psychological demands, and atypical work schedules are associated with a higher burden of morbidity.[246–248]

While only significant for self-reported depression, observed associations for all outcomes were of greater magnitude for tipped relative to untipped service work in women. In analyses restricted to women with no previous history of depression, women in tipped service occupations had greater odds of reporting depressive symptoms or diagnosis than women in untipped service. This finding may reflect characteristics of tipped work that make it more precarious than untipped work, such as more unstable income [3] and greater emotional labor demands.[190,249] In a bivariable examination of job characteristics by occupation type we found that a smaller proportion of tipped service had access to paid leave, health insurance, regular shift schedules, or freedom to make important decisions compared to those in untipped service and non-service occupations.

Higher odds of depression were not observed for men in tipped service. In addition to resulting in more unstable income for women, women in tipped work occupations earn less than men (Wave IV household income $48,500 versus $60,000 in men). Nationwide, women in tipped occupations earn 6% less per hour than men.[3] Part of this discrepancy is attributed to further gender-based occupational stratification. For instance, in our PS-restricted sample women in tipped service occupations were largely restaurant wait staff (44.3% of all women tipped service workers vs. 30.8% of all men tipped service workers). However, even among wait staff, women are less likely than their male counterparts to work in fine dining establishments.[161] Moreover, studies have found tipping practices to be discriminatory. One study found that women only earned equivalent tips to men when their service was rated by the customer as “exceptional”, suggesting that women are being held to higher standards, especially by male customers.[162] Another study found that male customers tipped more favorably if they found the female server attractive and/or she was wearing makeup.[163] Discrepancies in the occupation category-depression association may reflect gender-based differential

exposure to the discriminatory aspects of tipped service work. Researchers have also observed that the association between various psychosocial work exposures and poor mental health may differ by gender.[250] In service occupations in particular, having to manage challenging customers may undermine gender-role authenticity, with detrimental mental health effects.[251] As such, women may experience differential vulnerability to the emotional demands inherent to tipped and untipped service work.

Gender-based differences in observed associations may also be a product of gender differences in stratification into specific occupation types within the three categories we examined. Particularly among the PS-restricted sample (which largely excludes professionals), 68% of the "non-service" occupations filled by women are administrative in nature while 64% of the "non-service" occupations filled by men are blue collar physical labor-oriented occupations, with different job types providing a different constellation of physical, psychosocial and environmental exposures. Our observations are consistent with data from the Department of Labor on gender segregation in the workforce[252] and may partially explain some of the weaker associations observed with the other outcomes in men.

Our analysis has limitations. First, because we restricted our analytic sample, generalizability is limited to individuals from lower to middle class upbringings without college degrees. However, use of PSs enhanced internal validity. While the unrestricted analysis yields estimates that are nationally representative for adolescents followed into adulthood, these estimates were computed in a sample that contains individuals who are not exchangeable because of social stratification, as evidenced by the non-overlapping propensity distributions observed in **Appendix Figure A2.2A**. We further argue that given the bimodal distribution of the propensity for non-service among women in service occupations, our sample restriction likely removed affluent atypical individuals. For

instance, women entering service work despite having a high propensity for non-service work may be entering outlier occupations (e.g. fine dining establishments, high end salons) and/or be selecting this type of work for the flexibility it affords. Second, our estimates may be biased due to unmeasured confounding as PSs only balance measured variables. We posit that estimates observed from our restricted sample are more conservative than those in unrestricted analysis to account for unmeasured confounding that may make an individual with a high propensity for entering one occupation still enter another. Third, both exposure and outcomes are subject to misclassification error. While it is likely individuals were appropriately classified in service or not service industry professions, some degree of non-differential misclassification is expected upon determination of whether or not the occupation was tipped. Notably, specific occupations for those reporting tipped service work were predominantly occupations that are less ambiguous in regards to tipping status in the US. Here, we expect estimates would be biased towards the null. Also, self-report of study outcomes may introduce differential misclassification. The symptom recall periods for measures of perceived stress and sleep problems were one month while the recall period for depressive symptoms was one week. Researchers have observed a systematic bias in recall that is largest for those asked to reflect on a longer period of time.[253] Regardless, the consistency of the magnitude and direction of the observed associations for these three mechanistically interconnected outcomes irrespective of differences in recall periods lends credibility to our observed associations. Further, we leverage the use of a prospective cohort initiated in childhood, which allowed us to minimize recall bias and ensure temporality of the items included in the study. Notably, our sensitivity analysis restricting to individuals with no previous history of depression yielded larger point estimates among tipped service workers. We posit that because individuals in untipped service work experienced disproportionately more childhood

adversity relative to non-service and tipped service workers and the relationship between childhood adversity and childhood mental health,[254] this sensitivity analysis addressed further residual confounding related to childhood disadvantage. Fourth, 51% of the original *Add Health* sample did not complete all four waves and of those that did, 34% were missing one or more measure pertinent to PS development. We mitigate the potential introduction of selection bias by including sampling weights that account for loss to follow-up and multiply imputing in conjunction with PS development to address missing covariate data. While there is concern that certain variables were not missing at random – such as responses to childhood maltreatment questions –likely any bias introduced would bias estimates to the null. Fifth, we were unable to perform risk estimation procedures. Outcomes evaluated in this analysis are all prevalent in this population, however, we expect direction and magnitude of the associations to remain largely consistent; this was observed for models we were able to evaluate (**Appendix Table A2.6**). Sixth, the incorporation of PS in our analysis is limited in that within our statistical software we were unable to incorporate standard errors that accounted for multiple imputation. In addition, the 3-category exposure variable coupled with the complex survey design of the *Add Health* data limited our ability to incorporate PS beyond simple adjustment. While different approaches to the incorporation of PS in analyses can yield different results, our use of asymmetric trimming prior to analyses enabled us to procure estimates that are likely more similar to those that would be obtained through other PS methods.[255] Finally, our analyses may have been underpowered to detect further significant differences between occupation categories due in part to small sample sizes, particularly among tipped service workers.[256]

We conclude that the heightened precariousness of tipped service work may place individuals in these occupations – especially women – at increased risk of poor mental

health. Optimal public policy and employment practices to alleviate the excess risk of depression in tipped service workers will depend on understanding the factors that underlie these differences in health status.

CHAPTER 4: The Tipping Point: Could increasing the subminimum wage reduce poverty-related antenatal stressors in US women?

Sarah B. Andrea, Lynne C. Messer, Miguel Marino, Julia M. Goodman, and Janne Boone-Heinonen

Author Contributions: SBA conceived of the study, performed statistical analysis, and drafted the manuscripts. MM assisted with statistical analysis and interpretation of statistical findings and critically reviewed the manuscript. LCM and JMG assisted with the interpretation of study findings and critically reviewed the manuscript. JBH assisted with and supervised all aspects of the study and critically reviewed the manuscript. Components of this work were presented by SBA at Society for Epidemiologic Research Annual Meeting on June 20th, 2018 in Baltimore, MD. The authors would like to acknowledge the PRAMS Working Group and the CDC for providing the data used in the analysis reported in this article.

4.1 ABSTRACT

Tipped workers, primarily women of reproductive-age, can be paid a “subminimum wage” 71% lower than the federal minimum wage, contributing to economic hardship. Poverty-related antenatal stress has deleterious health effects for women and their children. Utilizing a difference-in-differences approach, we examined the impact of increases in the subminimum wage on cumulative poverty-related antenatal stress using data from 35 states participating in the Pregnancy Risk Assessment Monitoring System between 2004-2014, linked to state-level wage laws, census, and antipoverty policy data. Increases in subminimum wage were associated with decreased stress prior to and following the Great Recession. Setting the subminimum wage to 100% of the federal minimum wage (i.e. essentially eliminating a subminimum wage) was the only strategy that was not associated with increases in stress at any point during the study period. Increasing the subminimum wage can reduce poverty-related stress and may be an actionable strategy in reducing poor health outcomes.

4.2 INTRODUCTION

Poverty is a source of acute and chronic stressors.[257] One factor contributing to poverty in the United States (US) is the two-tiered minimum wage structure, which enables a reduced hourly wage for workers in tipped occupations.[3] At the federal level, this reduced wage for tipped workers - hereafter referred to as the subminimum wage - has been static at $2.13 since 1991.[3] As a result, tipped workers rely on unpredictable gratuities for the majority of their wages. Patronage and customer generosity are influenced by factors beyond workers' control, such as worker race, gender, and attractiveness,[3,162] as well as economic conditions.[258] While it is federally mandated that employers make up the difference when their tipped worker's wage plus tips is not equal to or greater than the minimum wage, this often does not occur.[181] Correspondingly, tipped workers are twice as likely to live in poverty relative to untipped workers.[3]

Notably, approximately 3 million women work in a tipped occupation in the US.[3] Women – especially during their reproductive years (18-44 years) – are 30% more likely to live in poverty than their male peers.[259] Twenty-five percent of women giving birth in the US live below the poverty level[260] and our previous work demonstrated an elevated burden of poor mental health for young women in tipped-wage occupations.[261] Importantly, there is an established relationship between maternal poverty-related stress and poor birth outcomes including low birthweight deliveries,[262] a risk factor for deleterious health effects into adulthood. Thus, maternal exposure to poverty-related stress has transgenerational consequences. However, policies aimed at addressing the shortcomings of the two-tiered minimum wage system represents an under-explored intervention for improving women's health.

While one-third of states in the US enforce the federal subminimum wage floor, other states have either independently passed legislation increasing the required employer contribution to tipped workers' wages, or require employers to pay all workers the minimum wage regardless of tip status.[176] The work reported here leverages variation in wage policy both within and across states over time to produce the first empirical investigation of the implications of state-level subminimum wage laws for the health of women. Our objective was to test the hypothesis that 1) increasing the subminimum wage is associated with reduced poverty-related antenatal stress; and 2) that increases in the subminimum wage are associated with the greatest reduction in poverty-related antenatal stress among women with both a higher probability of exposure to tipped work and disproportionately greater risk of consequences. We further estimated the extent to which historical, existing, and proposed wage policy scenarios could reduce the burden of poverty-related stress among vulnerable women.

4.3 METHODS

Sample

To evaluate the impact of subminimum wage on poverty-related antenatal stress, we used Pregnancy Risk Assessment Monitoring System (PRAMS) data from participating states spanning 2004-2014. PRAMS is an ongoing project of the Centers for Disease Control and Prevention (CDC) and state health departments to monitor perinatal and postpartum health, behavior, and outcomes.[263] PRAMS samples monthly from women who have recently given birth within each participating state using a sampling frame of birth records; women at higher-risk for adverse pregnancy outcomes are oversampled. Questionnaires are standardized across participating states and maternal responses are linked to data extracted from their infant's birth record. The CDC enforces a minimum

response rate threshold; data are released from states with a response rate ≥70% (2004-2007), ≥65% (2008-2012), and ≥60% (2013-2014).

To ascertain state characteristics beyond subminimum wage policy, we linked PRAMS data to publically available state-level contextual data from the University of Kentucky Center for Poverty Research,[264] the American Community Survey,[265] the Department of Labor,[176] and Wage and Hour laws archived on each state's labor office official website.[266]

Measures

Our exposure was the time-varying state-level subminimum wage in the participant's state of residence one year prior to her infant's birth; this lag period ensured that any change in wage policy preceded the outcome of interest. The mandated minimum hourly rates for tipped workers, and the date ranges associated with them, were abstracted from Wage and Hour laws retrieved from each state's labor office official website. In a given month, the state-level subminimum wage could stay the same, increase, or decrease, however the wage could not be below the federal subminimum wage ($2.13/hour).[177] Thus, the applicable subminimum wage for these analyses was the higher of either the state's subminimum wage or the federal subminimum wage. In instances where there was more than one state-level subminimum wage policy, we selected the policy that corresponded to food service workers, as waiters and bartenders make up 58% of the tipped-wage work force,[3] or subminimum wage stipulated for larger employers; these stipulations were mutually exclusive. We adjusted all calculations for inflation by converting all wage values to 2014 dollars.

Our primary outcome was cumulative poverty-related stress during pregnancy, which can include economic strain, family conflict, and exposure to violence.[257] PRAMS

respondents in all states were asked a series of questions every year about stressful events that happened during the 12 months preceding the birth of their new infant. A total cumulative poverty-related stress score ranging from 0-10 was constructed by summing affirmative responses to questions in the domains of economic hardship and relationship conflict. Stressors in the domain of economic hardship included: (1) moved to a new address; (2) was homeless; (3) husband/partner lost their job; (4) lost her job although she wanted to continue working; and (5) had a lot of bills that she could not pay. Stressors in the domain of relationship conflict included: (1) separated/divorced from husband/partner; (2) argued with husband/partner more than usual; (3) husband/partner did not want the pregnancy; (4) she or her husband/partner went to jail; and (5) experienced physical abuse by husband/partner and/or ex-husband/partner.

Vulnerable subgroups were defined based on characteristics derived from substantive knowledge and the literature: educational attainment, race/ethnicity, marital status, and parity. We postulated that multiparous unmarried Non-White or Hispanic women with less than a college degree would be the most vulnerable, and therefore most impacted by subminimum wage policy change.

We accounted for potential confounders and effect modifiers by incorporating individual and state-level covariates (**Appendix Figure A3.1**). Individual-level covariates from the time of delivery included educational attainment (<college, college graduate), race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, non-Hispanic American Indian, Hispanic, or other non-White specific race/ethnicity unknown), marital status (married, unmarried), parity (nulliparous, multiparous), and continuous age. State-level covariates included time-varying state sociodemographic composition (percent non-Hispanic White, percent college graduates, percent working in the service industry, percent unemployed, percent food insecure, percent living under the federal

poverty level, and median household income) and state public policy (median welfare benefit package and average proportion of democratic representation in state legislature). All dollar values were converted to 2014 dollars. State-level covariates were lagged by two years from date of birth (2002-2012) to ensure they preceded changes to wage policy.

Analytic Sample

Our original data set contained 428,397 women from 38 states giving birth between 2004-2014. To ensure sufficient data to observe trends over time, analyses were restricted to states with releasable data for ≥2 years during the study period (35 states, 424,594 women, **Appendix Table A3.1**)**.** We restricted our sample to women ≥20 years of age (40,492 excluded) so as to not confound our analysis by the legally permissible reduced hourly rate employers are permitted to pay workers <20 years of age.[267] We further required complete responses to questions relating to stressors in the domains of economic hardship and relationship conflict (3% excluded, N=13,423). After accounting for missing values in individual-level covariates, our final sample consisted of 364,588 women giving birth between 2004-2014 in 35 states.

Statistical Analysis

Analyses were conducted in Stata (StataCorp LP, College Station, Texas). Primary analyses were stratified by maternal education level (<college, college graduate), as women with less than a college degree are disproportionately more likely to work in tipped occupations.[261] Analysis was conducted on data aggregated by state and month; therefore, state-months were the unit of analysis. Aggregation was performed within strata of educational attainment and incorporated weights provided by PRAMS to account for sampling strategy, nonresponse, and frame noncoverage. This yielded 3,389

state-months for women with less than a college degree and 3,388 state-months for women with a college degree or more (35 states contributing 24 to 131 months for each). In addition to maternal education level, we considered secondary analyses where we examined the subminimum wage policy within our *a priori* defined vulnerable subgroup of multiparous unmarried Non-White or Hispanic women with less than a college degree, and within each component of this vulnerable subgroup separately. For these effect modification analyses, aggregation was performed within strata of defined vulnerable subgroups.

Applying mixed effects linear regression, we used a difference-in-differences model[268] to estimate the cumulative number of poverty-related antenatal stressors in response to monthly changes in state-level subminimum wage. This approach accounts for unobservable time-invariant and time-variant differences between states that changed their wage policies and states that did not. To address a non-linear trend of cumulative stress over time and enhance interpretability of results, we divided time of PRAMS outcome ascertainment into three separate periods: 2004-2008, 2009-2011, and 2012-2014. These periods simultaneously correspond to different phases of PRAMS surveys and wage policy exposure prior to (2003-2007), during (2008-2010), and following (2011-2013) the Great Recession. The statistical model is described in detail in **Appendix 3.A.** Model diagnostics included visual examination for residual distribution, outlier detection, and assessment of the parallel trends assumption.

Identifying an effective wage policy intervention. In policy simulations based on mixed effects model coefficients, we estimated effects of four hypothetical subminimum wage policy scenarios: (1) a flat $2.13, the current federal subminimum wage since 1991;[3] (2) 50% of the federal minimum wage as it was prior to a 1996 addendum of the Fair Labor Standards Act; (3) 70% of the federal minimum wage as was proposed in S.

1737 (113th): Minimum Wage Fairness Act; and (4) equivalent to the federal minimum wage ($5.15-$7.25).

4.4 RESULTS

Description of the Sample. Table 1 displays the characteristics of postpartum women by educational attainment for the first and final years of the studied period (2004 and 2014, respectively). Women with less than a college degree were less likely to be White or married, more likely to be living below the federal poverty level and reported a greater number of poverty-related stressors during their pregnancy (mean: 1.58 vs. 0.73 for college educated women in 2004). The mean number of reported poverty-related stressors decreased over time for women with and without a college degree, with an 8% and 16% decrease by 2014, respectively.

From 2003 to 2013, the state subminimum wage in 2014 dollars averaged $3.96 (SD: 1.95) and ranged from $2.17 to $9.49. There were 86 changes in state subminimum wage, with the change averaging +$0.34 (SD = 0.42) and ranging from -$1.82 to +$1.94 (data not shown). States with subminimum wage policies above the federal subminimum wage had less food insecurity and higher median household income, provided greater welfare packages, and were disproportionately governed by democratic politicians (**Table 2**).

The mixed effects model coefficients and narrative description of the model can be found in **Appendix Table A3.2** and **Appendix 3.B**, respectively. To enhance interpretability, we interpret the coefficients in an illustrative example in the next section.

Table 4.1. Characteristics of Postpartum Women[a] by Educational Attainment, PRAMS

	<College Degree		>= College Degree	
	Baseline Year 2004, % (N = 24,513)	Final Year 2014, % (N = 18,290)	Baseline Year 2004, % (N = 10,720)	Final Year 2014, % (N = 10,092)
Sociodemographic Characteristics				
Maternal Age (years)	27.68 (0.06)	28.31 (0.06)	31.98 (0.06)	32.35 (0.06)
Maternal Race/Ethnicity				
Non-Hispanic White	55.9	55.8	78.0	75.0
Black	18.3	16.1	7.8	6.2
Asian	3.1	4.1	7.2	10.0
AI/AN/Hawaiian	1.8	1.5	0.5	0.2
Hispanic	20.1	19.2	5.9	6.4
Non-White, Specific Unknown	0.8	3.3	0.6	2.2
Married	58.7	48.9	92.4	89.9
Multiparous	66.8	67.4	53.4	55.4
Relationship to Federal Poverty Level				
0 to 100%	43.6	46.1	6.6	5.8
101 to 200%	26.9	29.4	13.3	12.3
>200%	29.5	24.5	80.1	81.8
Outcomes				
Mean Number of Reported Poverty-Related Antenatal Stressors[b]	1.58 (0.02)	1.33 (0.02)	0.73 (0.02)	0.67 (0.01)
Economic Hardship	0.99 (0.01)	0.86 (0.01)	0.49 (0.01)	0.47 (0.01)
Moved to a new address	37.5	34.7	27.8	27.6
Experienced homelessness	4.6	2.7	0.5	0.3
Husband or partner lost their job	13.9	12.5	7.4	6.1
Had a lot of bills she couldn't pay	30.3	23.7	9.5	9.0
Lost her job even though she wanted to go on working	13.0	12.7	4.1	3.7
Relationship Conflict	0.59 (0.01)	0.47 (0.01)	0.24 (0.01)	0.20 (0.01)
Separated or divorced from her husband or partner	11.2	8.7	2.6	1.9
Argued with her husband or partner more than usual	28.2	23.2	16.3	13.5
Husband or partner said he didn't want her to be pregnant	10.2	7.6	4.0	3.5
Respondent, husband, or partner or went to jail	5.0	4.7	0.7	0.7
Partner/ex-partner pushed, hit, slapped, choked, or physically hurt respondent in any way	4.3	2.4	0.8	0.8

PRAMS, Pregnancy Risk Assessment Monitoring System

Percentages, means, and standard errors are calculated by accounting for survey weights, strata, and clusters

[a]Includes women aged 20 and older residing in states with released PRAMS data for at least 2 years during the 2004-2014 studied period

[b]Values are expressed as mean (standard error)

Illustrative Application of Multivariable Models. In policy simulations based on our mixed effects model coefficients, we estimated effects of two hypothetical subminimum wage policy scenarios within *a priori* vulnerable subgroups (**Figure 1).** When subminimum wage remained at $2.13 for the duration of the studied period (Scenario 1), poverty-related stressors decreased by 10.8% for women without a college degree and by 9.2% for women with a college degree. When the subminimum wage was set to be the same as the federal minimum wage ($5.15-$7.25; Scenario 2), poverty related stressors decreased by 18.2% for women without a college degree and 6.9% for women with a college degree. The strength of observed associations were strongest for women in the *a priori* defined most vulnerable subgroup: unmarried, multiparous, non-White women with less than a college degree.

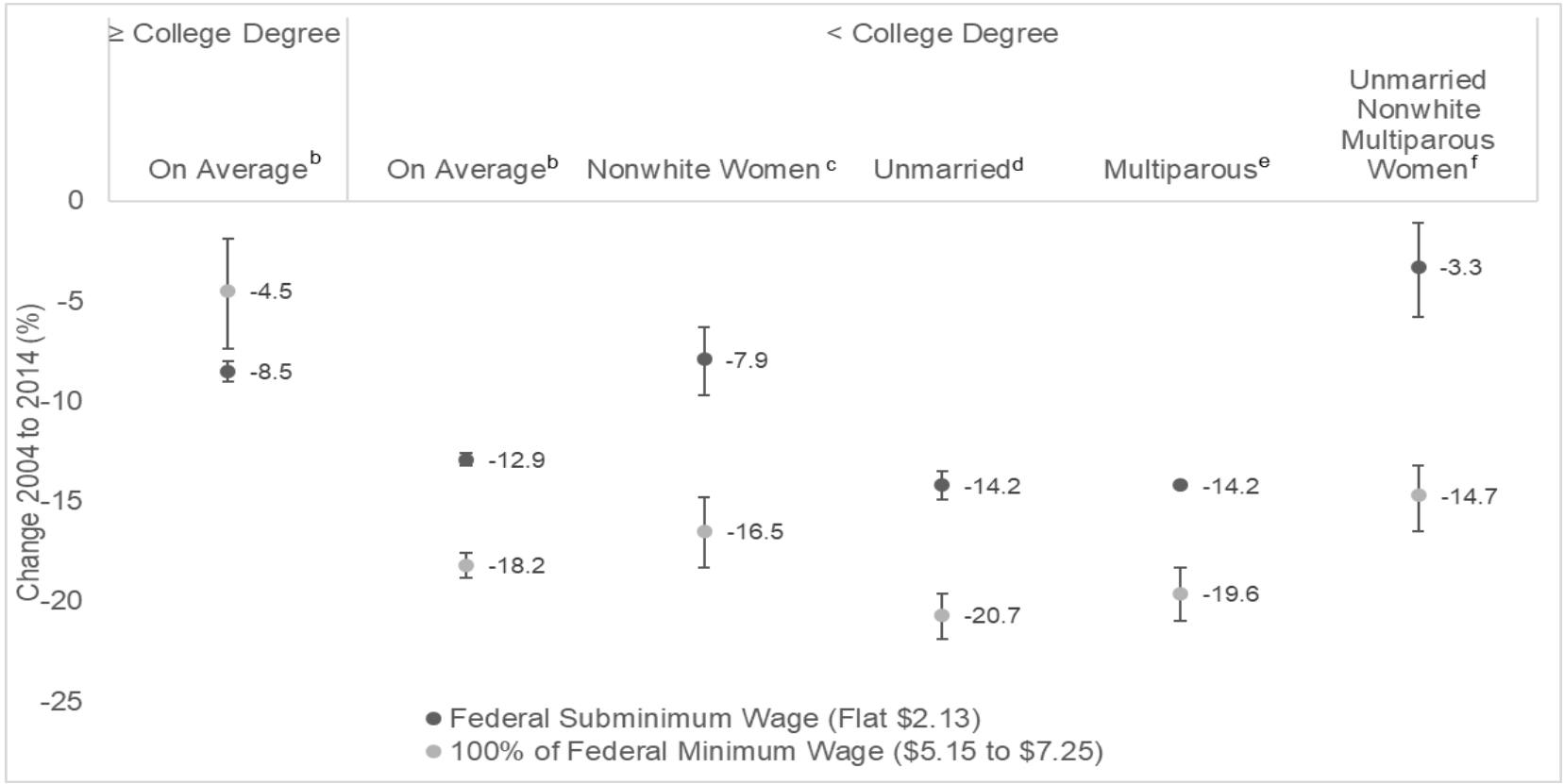
Identification of an Effective Wage Policy Intervention. We examined four subminimum wage policy scenarios in the *a priori* defined vulnerable subgroup (**Figure 2).** From 2004-2008, subminimum wage policy set to ≤70% of the federal minimum wage was associated with a 1-7% increase in poverty-related stressors, while wages set to 100% of the federal minimum were associated with a 4% decrease in poverty-related stress. Conversely, from 2009-2011 all examined wage policies were associated with a reduction in poverty-related stress; wages set to the federal subminimum $2.13 were associated with the largest reduction, however, poverty-related stress at the beginning and end of this period was also highest under this scenario. Finally, from 2012-2014 an applicable subminimum wage policy set to ≤50% of the federal minimum wage was associated with a 2-5% increase in poverty-related stressors for our most vulnerable women, while wages set to 100% of the federal minimum yielded a 6% decrease in poverty-related stress.

Table 4.2. Characteristics of States[a] by State-Level Subminimum Wage Category

	Baseline year (2002)[c]			Final year (2012)[d]		
	At federal subminimum wage[e], % (N =12)	Between federal subminimum and minimum wage[f], % (N = 18)	Federal minimum wage or greater[g], % (N = 5)	At federal subminimum wage[e], % (N = 10)	Between federal subminimum and minimum wage[h], % (N = 22)	Federal minimum wage or greater[i], % (N = 3)
Percent White	77.4	83.1	70.3	74.3	78.8	76.7
Percent College Graduate	23.6	25.8	28.3	27.2	29.6	29.9
Percent Employed in Service Industry	16.3	16.0	17.0	17.7	18.2	18.8
Unemployment Rate	5.4	5.2	6.2	7.6	7.2	8.0
Percent Food Insecure	13.9	10.7	13.2	17.1	15.2	13.8
Poverty Rate	12.7	11.2	9.7	15.5	13.5	11.7
Median Household Income ($)[b]	40,143 (1,554)	43,975 (1,674)	48,676 (2,679)	49,022 (2,990)	53,083 (1,809)	58,148.67 (5,362)
Median Welfare Benefit Package ($)[b]	504.92 (22.28)	614.28 (29.36)	792.40 (87.52)	648.50 (41.08)	767.04 (30.36)	915.33 (140.49)
Minimum Wage ($)[b]	5.08 (0.08)	5.47 (0.13)	6.49 (0.37)	7.28 (0.03)	7.41 (0.12)	8.63 (0.44)
Average Democratic Composition of State Governance (i.e. Senators, Representatives, Governor)	40.9	55.1	61.7	26.9	54.9	56.1

[a]Includes the 35 states with two or more years of releasable PRAMS data from 2004-2004
[b]Values are expressed as mean (standard error)
[c]Lagged two years; linked to PRAMS outcomes measured in 2004
[d]Lagged two years; linked to PRAMS outcomes measured in 2014
[e]$2.13/hour
[f]$$2.14 to $5.14/hour
[g]≥$5.15/hour
[h]$2.14 to $7.24/hour
[i]≥$7.25/hour

Figure 4.1. Change in mean cumulative poverty-related stressors for baseline year to final year by subminimum wage policy as estimated in multivariable mixed effects models[a]

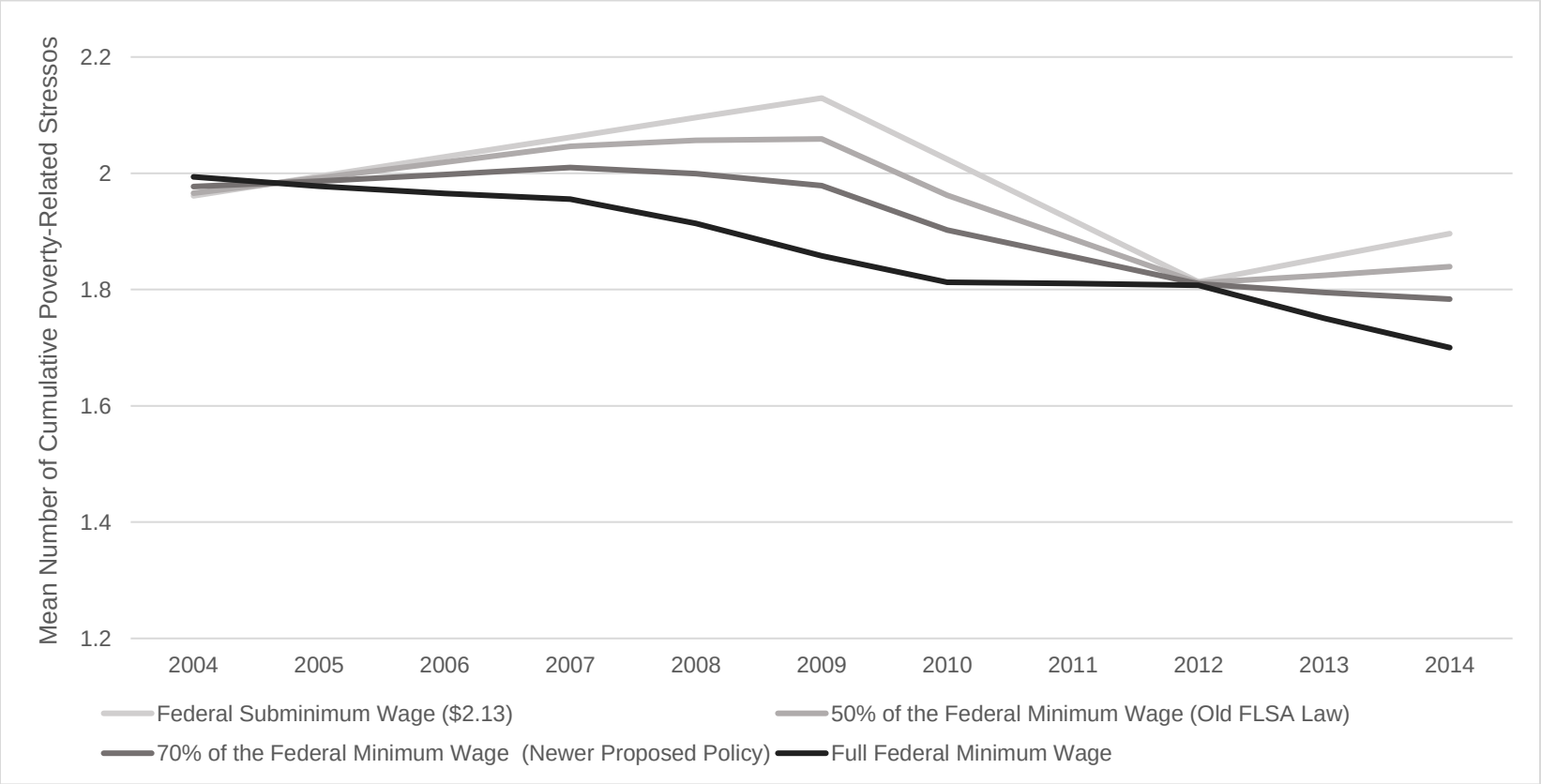


Caption: Estimated effects of two hypothetical subminimum wage policy scenarios on cumulative poverty-related stress within a priori vulnerable subgroups. Point estimate and 95% confidence intervals are presented.

Source: Authors' analysis of data from the Pregnancy Risk Assessment Monitoring System (PRAMS), the American Community Survey, University of Kentucky Center for Poverty Research, and the Department of Labor

[a]All models adjust for state-level variables lagged two years from PRAMS outcome ascertainment (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, % in service occupation, % unemployed, % food insecure, and median household income. Models include additional adjustment for state-month mean PRAMS variables as follows: [b] % black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % married, % multiparous; [c]maternal age, % married, % multiparous ;[d]% black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % multiparous; [e]% black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % married; [f]maternal age

Figure 4.2. Predicted number of cumulative self-reported poverty-related stressors prior to pregnancy in unmarried, multiparous, non-White women with less than a college degree by subminimum wage policy[a], PRAMS 2004-2014



Caption: Estimated mean number of cumulative poverty-related stressors over time under four historical, existing, and proposed wage policy scenarios among women with both a higher probability of exposure to tipped work and disproportionately greater risk of consequences
FLSA, Fair Labor Standards Acts; PRAMS, Pregnancy Risk Assessment Monitoring System
Source: Authors' analysis of data from the Pregnancy Risk Assessment Monitoring System, the American Community Survey, University of Kentucky Center for Poverty Research, and the Department of Labor
[a]Model adjusted for state-level variables lagged two years from PRAMS outcome ascertainment (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, % in service occupation, % unemployed, % food insecure, and median household income, and PRAMS state-month mean maternal age

DISCUSSION

This study estimated the effects of increasing the state-level subminimum wage on poverty-related stressors experienced during pregnancy. For women with less than a college degree – particularly multiparous women who were non-White, and unmarried – changes in the state-level subminimum wage were associated with greater reductions in the reported number of stressors over time. These associations were not observed among women with a college degree. In our examination of the potential impact of 4 different hypothetical subminimum wage policies, we found that the most conservative policy – maintaining the current federal subminimum wage of $2.13 – is associated with an *increase* in poverty-related stressors among the most vulnerable women in recent years (2012-2014). The most progressive policy – setting the subminimum wage to the federal minimum wage – was the only strategy that was associated with a decrease in poverty-related stressors from 2012-2014 and was not associated with increased stressors at any point during the studied period (2004-2014).

Our study is the first to examine the implications of state-level subminimum wage laws for the health of women. Our finding that increases in subminimum wage are associated with a net decrease in poverty-related stressors are consistent with those observed in other studies examining the health implications of wage policies aimed at increasing the incomes of working class families.[219] For example, studies have projected that a $1 increase in the minimum wage would result in 2,790 fewer low birthweight births annually.[28] Others have observed that increasing the minimum wage is associated with a reduction in unmet medical needs[131] and reduced depressive symptoms[25] and mental strain[221] in low wage workers. An assessment in New York City estimated that a $15 minimum wage could have averted as many as 2,800 to 5,500 all-cause premature deaths.[26] Modification of health behaviors, leisure expenditures, and financial stress

have been highlighted and evaluated as mechanisms underlying the observed improvements in health in response to wage increases.[226]

As hypothesized, we observed that increases in the subminimum wage were associated with the greatest reduction in poverty-related antenatal stress among women with both a higher probability of exposure to tipped work and disproportionately greater risk of consequences. Women with less than a college degree are disproportionately more likely to work in tipped occupations.[261] This is further compounded by marital status and race. Unmarried women are disproportionately exposed to low-wage work and poverty,[154] which may be further exacerbated by the additional costs and resource demands of a single parent. Women of color are both disproportionately exposed to service work[269] and earn less in tips from customers than non-Hispanic White women.[158] As such, unmarried women of color with less than a college degree stand the most to gain from a wage policy that enables them to be less reliant on discriminatory customer tipping practices to earn a living wage.

Our findings during the 2009-2011 period should be interpreted within the context of the Great Recession, as they correspond to antenatal stressors experienced between 2008-2010. During the 2009-2011 period, we observed a reduction in poverty-related stress that was largest when the state-level subminimum wage policy was a static $2.13. In addition to the impact of economic conditions on fertility described in the limitations below, we posit this finding may be attributed to two factors: 1) the roll-out of the American Recovery and Re-Investment Act; and 2) the heterogeneous impact of the Recession on employment, spending, and earnings.

First, in 2009, additional tax credits, unemployment benefits, home heating subsidies, and food stamp assistance were rolled out as part of the American Recovery and Re-

Investment Act to buffer the impact of the Great Recession, especially for low-income families.[270] Since eligibility for these resources was income-based, the more pronounced decrease in stressors during this time period especially in states with low wage policy may be because individuals earning a lower subminimum wage had greater access to these subsidies.

Second, during the Great Recession, job loss was disproportionately higher among "leisure and hospitality" sector employees and restaurant sales fell as consumers reduced spending on discretionary purchases.[258] As such, even among those who did not experience job loss, tips from customers during this time may also be less generous. Without adequate supplementation of wages with tips from customers, the potential benefit of an increased hourly wage is complicated. Small increases to wage standards may push individuals just over the poverty threshold, an important cutoff for social services, resulting in less net resources in some states. For example, in Indiana, a single parent with two children loses access to SNAP as their income approaches $11/hour and a $9000 childcare benefit as their income approaches $15/hour.[218]

Taken together, we posit that maintaining the two-tier minimum wage system and marginally reducing the gap in minimum hourly wages between tipped and untipped workers may not be sufficient for addressing health inequities in this population. As noted above, we observed that setting the subminimum wage to 100% of the federal minimum wage – that is, no longer permitting a subminimum wage – was the only strategy that was not associated with increases in poverty-related stress at any point during the study period. The subminimum wage is but one potential target for reducing the precariousness of tipped wage work.[261] Each of the policies we consider in this study assumes that tipping is still a common practice. "Non-gratuity" policies, which prohibit tipping and are generally accompanied by increased wages, are another point of

consideration; some restaurants have implemented such policies with mixed success.[271] Examining the implications of "non-gratuity" policies was beyond the scope of this study but is an important point of consideration for future research. In addition, exploring interventions that apply to the workforce more broadly, through addressing aspects like unpredictable schedules, are paramount.

This study has important limitations. First, we estimated the effect of subminimum wage change on poverty-related stress at the state level, but fewer than 10% of employed women in the US work in tipped occupations.[3] We suspect the disproportionately greater number of untipped workers in our state-level analyses may lead to more conservative estimates. However, it is important to understand the implications of broadly applied policy for the population at large. Moreover, our vulnerable subgroup analysis enabled us to observe effects in populations with a greater probability of exposure to tipped work. Second, the release of state-level PRAMS data is contingent on meeting the CDC-mandated response rate; response rates are influenced by both state-level and individual-level participant factors. States with ≥2 years of releasable data were disproportionately states with more generous wage policy (**Appendix Table A3.1**). We suspect comparatively lower response rates in states with low subminimum wage coupled with differential non-response of more vulnerable women would lead to more conservative estimates. Third, we examined and totaled dichotomized measures for stressors, which cannot capture iterative changes in stress that other studies can[257] and may lead to more conservative estimates. Moreover, the construct validity of questions on economic hardship related to joblessness may be time-variant, as unemployment rates are decreasing[272] but underemployment is increasing.[273] Finally, the analytic sample is restricted to women who have had a recent live birth, which may introduce survival bias. Wage policy and national economic trends impact fertility[27] and antenatal

stress exposure is associated with an increased risk of miscarriage;[274] as such we anticipated this would bias our results towards the null. However, the magnitude of bias for conditioning on live births is generally small,[275] and our analyses incorporate individual-level factors that are risk factors of both poverty-related stress and spontaneous abortion.

CONCLUSIONS

While the relationship between poverty and poor health is well documented and widely recognized, greater attention to examining viable strategies to ameliorate poverty is needed. Our study adds to an emerging literature evaluating the role of income-support policies for improving the health of our most vulnerable populations. Increasing the subminimum wage may be an actionable strategy to reduce antenatal stress and, in turn, poor health outcomes in low-income women and their children.

CHAPTER 5: A Nationwide Investigation of the Impact of the Tipped Worker Subminimum Wage on Infant Size for Gestational Age

Sarah B. Andrea, Lynne C. Messer, Miguel Marino, Julia M. Goodman, and Janne Boone-Heinonen

Author Contributions: SBA conceived of the study, performed statistical analysis, and drafted the manuscripts. MM assisted with statistical analysis and interpretation of statistical findings and critically reviewed the manuscript. LCM and JMG assisted with the interpretation of study findings and critically reviewed the manuscript. JBH assisted with and supervised all aspects of the study and critically reviewed the manuscript. Components of this work were presented by SBA at the Population Association of America Annual Meeting April 2019 in Austin, Texas.

5.1 ABSTRACT

Objectives. To estimate the effects of increasing the state-level tipped worker subminimum wage (federally, $2.13 per hour) on infant size for gestational age in the US.

Methods. Utilizing unconditional quantile regression and difference-in-differences analysis of data from 2004-2016 Vital Statistics Natality Files, linked to state-level wage laws, census, and antipoverty policy data, we estimated the effect of increasing the subminimum wage on birthweight standardized for gestational age (BWz). Smallest and largest infants are defined as those in the 5th and 95th BWz percentiles, respectively.

Results. Increases in the subminimum wage were associated with a slight leftward shift and a narrowing of the BWz distribution. When compared to a static wage of $2.13 for the duration of the study period, wage set to 100% of the federal minimum ($5.15-$7.25) was associated with an increase in BWz of 0.039 (95% CI: 0.033, 0.044) for the smallest infants and a decrease by 0.051 (95% CI: -0.058,-0.045) for the largest infants.

Conclusion. Increasing the subminimum wage may be one strategy to promote healthier birthweight in infants.

5.2 INTRODUCTION

Driven by a myriad of factors, including poverty-related stress and malnutrition, maternal socioeconomic disadvantage prior to and during pregnancy is robustly associated with adverse birth outcomes.[17] One factor that may contribute to maternal socioeconomic disadvantage in the United States (US) – where approximately 3 million women work in a tipped occupation[276] – is the two-tiered minimum wage structure that permits a reduced hourly wage for workers in tipped occupations.[177] At the federal level, this "subminimum wage" has been frozen at $2.13 since 1991. Consequently, tipped workers are reliant on unpredictable gratuities for the majority of their wages.[3] Correspondingly, tipped workers are twice as likely to live in poverty relative to untipped workers[3] and young women in tipped occupations experience an elevated burden of poor mental health relative to similar women in other occupation types.[261]

Leveraging the heterogeneity in subminimum wage policy across and within states over time, a previous study found that increasing the subminimum wage was associated with a reduction in poverty-related antenatal stress. This finding was particularly pronounced among vulnerable subgroups of women who theoretically have the highest probability of exposure to tipped work and experience differential vulnerability due to factors like their race, educational attainment, and marital status (**Chapter 4**). However, the potential implications of increasing the subminimum wage for health of the next generation are underexplored.

Among birth outcomes, low birthweight and preterm birth are the most frequently evaluated in reproductive outcomes research. However, when considering the implications of applying a state-level policy like subminimum wage to the whole population, infant size for gestational age is of particular interest, as both infants born small or large are at risk for poor health across the lifecourse.[21–24] Previous examinations

of the effects of income support policies on infant birthweight have largely focused on increasing birth weight in infants who are born small,[28] or examined associations with mean birthweight using classical linear regression[29] – an approach that can mask differential effects that may be occurring at different places in the birthweight distribution. That infants at both tails of the birthweight distribution are at risk of poor health raises important concerns when considering interventions that are applied at the population level. Namely, if an intervention has the same effect across the entirety of the birthweight distribution, interventions aimed at increasing birth weight among infants born small for gestational age will do the same for large for gestational age infants, and vice versa for interventions aimed at reducing birth weight among large for gestational age infants; that is, move the whole distribution of birthweight for gestational age to the left or right. In contrast, an ideal population-level intervention for birthweight for gestational age would simultaneously increase birth weight in the smallest infants while decreasing birth weight in the largest infants, narrowing the distribution of birthweight for gestational age and accomplishing the intervention goal of improving population health.[105]

The objective of this study was to estimate the impact of changes in the subminimum wage policy on the location (e.g. shifts to the left or right) and dispersion infant size for gestational age distribution. We further estimated the extent to which historical, existing, and proposed wage policy scenarios could promote or inhibit healthier birthweight in infants.

5.3 METHODS

Data

We examined individual birth records from the U.S. Vital Statistics Natality Files, reported by all 50 states and the District of Columbia to the National Center for Health Statistics. We linked natality data to state-level wage policy data ascertained from the

US Department of Labor and state labor office websites.[266] To ascertain state characteristics beyond subminimum wage policy, we also linked natality data to publicly available state-level contextual data from the University of Kentucky Center for Poverty Research[264] and the American Community Survey.[265] This study was exempted by our institutional review board.

Measures

Our exposure was the time-varying state-level subminimum wage in the mother's state of residence two years prior to her infant's birth. The mandated minimum hourly rates for tipped workers, and the date ranges associated with them, were abstracted from Wage and Hour laws retrieved from each state's labor office website. In a given month, the state-level subminimum wage could stay the same, increase, or decrease, however the wage could not be below the federal subminimum wage ($2.13 per hour).[177] Thus, the applicable subminimum wage for these analyses was the higher of either the state's subminimum wage or the federal subminimum wage. In instances where there was more than one state-level subminimum wage policy in a given month, we selected the policy that corresponded to food service workers, as waiters and bartenders make up 58% of the tipped-wage work force,[3] or subminimum wage stipulated for larger employers; these stipulations were mutually exclusive as states only dictated one or the other.

Our primary outcome was continuous infant birthweight for gestational age Z-score (BWz). This variable was constructed using natality data for continuous birthweight in grams and gestational age in weeks and the reference population described by Talge et al.[277] as the external standard. Infant size for gestational age was determined to be plausible if z-scores were between -5 and 5 for term births (>37 weeks) or between -3 and 2 for preterm births (≤ 37 weeks).[278] We subsequently identified additional implausible gestational age values using a method described by Alexander et al.[279]

We accounted for potential confounders and effect modifiers by incorporating individual and state-level covariates. Individual-level covariates from the time of delivery, selected based on prior literature, were ascertained from the birth record and included maternal educational attainment (<high school, high school, some college, college graduate), maternal race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic American Indian or Alaskan Native, Non-Hispanic Asian or Native Hawaiian or Pacific Islander, Hispanic), maternal marital status (married, unmarried), parity (nulliparous, multiparous), maternal nativity (US native, foreign born), and maternal continuous age (linear and quadratic terms). State-level covariates included time-varying state sociodemographic composition (percent non-Hispanic White, percent college graduates, number working in the food service industry, percent unemployed, percent food insecure, percent living under the federal poverty level, and mean personal income) and state public policy (median welfare benefit package and average proportion of democratic representation in state legislature). We adjusted all calculations for inflation by converting all dollar values to 2014 dollars.[280]State-level covariates were lagged by three years from date of birth (2001-2013) to ensure they preceded changes to wage policy.

Analytic Sample

Our original data set contained 53,067,840 mother-infant dyads. Because state of residence was used to determine a mother's subminimum wage policy exposure, data were restricted to women residing in the US (N=52,960,994). We restricted our sample to women ≥20 years of age (N=48,382,049) so as to not confound our analysis by the legally permissible reduced youth minimum wage.[267] We further required singleton births (N=46,638,549) with gestational age 22-44 weeks (N=46,145,206) and birthweight. We retained infants with plausible BWz as described above (779,753 (1.7%) excluded).

Next, while all states capture maternal education across all years in the studied period, due to discrepancies in how education is recorded across versions of the US standard certificate of live birth,[281] education is only included in the NVSS public use file for states and jurisdictions that have implemented the 2003 revision of the birth certificate (**Appendix Figure 4.1**). Thus, we further restricted sample to state-years for which education data are not excluded from public use file (N=3,236,835 (7.1%) excluded). After accounting for missing values in individual-level characteristics (908,665 (2.1%) excluded), our final sample consisted of 41,219,953 women giving birth between 2004 and 2016 in all 50 states and the District of Columbia.

Statistical analysis

All analyses were conducted in Stata version 14.2 (StataCorp LP, College Station, Texas). A detailed description of our statistical approach is available in **Appendix 4.A**. Briefly, we used unconditional linear quantile mixed effects regression to estimate the impact of subminimum wage change over time on the location and scale of the infant BWz distribution.[282] We integrated a difference-in-differences approach [268] to account for unobservable differences between individuals in states that changed their wages and states that did not. That is, we estimated separate mixed effects regression models at every 5th percentile across the continuum of the BWz distribution, essentially estimating the association for the 5th, 10th,…, 95th quantiles. The pertinent coefficients are those corresponding to the interaction between the time-varying state-level subminimum wage and time. To address a non-linear trend of size for gestational age over time, calendar year was incorporated in the model as a series of categorical indicator variables. To assess the robustness of our estimates to the state-level discrepancies in the availability of education data during some years, we subsequently restricted analyses to states with

maternal education data available for the entire study period (29 states and DC; N=29,914,598 mother-infant dyads).

Identifying an effective wage policy intervention: policy simulations. Using coefficients from the quantile models, we estimated effects of four hypothetical subminimum wage policy scenarios for infants in the smallest (5th percentile) and largest (95th percentile) quantiles: (1) a flat $2.13, the current federal subminimum wage since 1991; (2) 50% of the federal minimum wage as it was prior to a 1996 addendum of the Fair Labor Standards Act; (3) 70% of the federal minimum wage as was proposed in S. 1737 (113th): Minimum Wage Fairness Act; and (4) equivalent to the federal minimum wage ($5.15-$7.25).

5.4 RESULTS

Table 5.1 displays characteristics of mother-infant dyads and their state of residence by select percentiles of the unconditional distribution of BWz for infants born during the first year of the studied period (2004). Relative to infants in larger quantiles, the smallest infants (5th percentile) were disproportionately born to women who were younger, Black, had lower educational attainment, were unmarried, and/or nulliparous. In terms of pregnancy conditions, hypertension was most prevalent among the mothers of the smallest infants while diabetes was most prevalent among the mothers of the largest infants (95th percentile). The state of residence for mothers of the smallest infants had slightly lower mandated subminimum wage on average as well as smaller welfare packages.

From 2002 to 2014, the state tipped worker subminimum wage in 2014 dollars averaged $3.97 (SD: 1.99) and ranged from $2.13 to $9.40. There were 140 changes in state subminimum wage, with the change averaging +$0.34 (SD = 0.46) and ranging from -$1.84 to +$1.94 (**Appendix Figure 4.2**).

Table 5.1. Characteristics[a] of mother-infant dyads and their state of residence by infant birthweight for gestational age percentile, 2004 U.S. Vital Statistics Natality Files

	Birthweight for Gestational Age Percentile				
	5th	25th	50th	75th	95th
Individual-Level Characteristics					
Maternal Age (years)[b]	27.70 (0.18)	27.79 (0.18)	28.21 (0.17)	28.63 (0.16)	29.10 (0.15)
Maternal Race/Ethnicity					
Non-Hispanic White	47.8	51.3	56.4	60.8	64.6
Non-Hispanic Black	22.3	17.8	13.8	11.2	9.3
Non-Hispanic AI/AN	0.9	0.8	0.8	0.9	1.0
Non-Hispanic Asian/NHOPI	7.7	7.9	6.6	5.3	4.1
Hispanic	21.3	22.2	22.4	21.9	21.1
Educational Attainment					
< High School	22.9	19.8	17.6	16.1	15.1
High School	34.0	31.4	29.3	28.0	26.9
Some College	22.4	23.4	24.0	24.5	24.9
≥ College	20.7	25.4	29.1	31.5	33.2
Maternal Nativity					
US Native	74.9	73.4	74.1	75.5	77.1
Foreign Born	25.1	26.6	25.9	24.5	22.9
Maternal Marital Status					
Married	57.0	63.3	68.5	72.1	74.9
Unmarried	43.0	36.7	31.5	27.9	25.1
Parity					
Nulliparous	44.0	41.4	38.1	34.9	33.4
Multiparous	56.0	58.6	61.9	65.1	68.7
Infant Sex					
Female	48.2	49.2	49.0	48.9	48.4
Male	51.8	50.8	51.0	51.1	51.6
Gestational Age (weeks)[b]	38.99 (0.02)	38.98 (0.03)	38.86 (0.03)	38.76 (0.03)	38.67 (0.04)
Extremely Preterm (22-27 weeks)	0.6	0.4	0.4	0.4	0.4
Very Preterm (28-31 weeks)	1.1	0.7	0.6	0.6	0.6
Preterm (32-36 weeks)	7.6	6.5	7.1	8.0	9.7
Term (37-42 weeks)	86.3	88.9	89.2	88.8	87.8
Post-term (42-44 weeks)	4.3	3.5	2.8	2.2	1.5
Diabetes (Gestational and/or Pre-pregnancy)	3.6	3.3	3.3	3.5	4.2
Any Hypertension	9.7	5.8	4.5	4.1	4.1
Chronic Hypertension	1.9	1.2	1.0	0.9	0.9
Eclampsia	0.7	0.4	0.2	0.2	0.2
Pregnancy Associated Hypertension	7.3	4.4	3.4	3.1	3.1
State-Level Characteristics[c]					
Subminimum Wage ($)[b]	3.15 (0.45)	3.21 (0.47)	3.25 (0.48)	3.27 (0.48)	3.29 (0.48)
Percent White	74.2	74.4	74.6	74.8	75.1
Percent College Graduate	26.0	26.1	26.2	26.2	26.2
Number Employed in Food Service (10,000s)	41.40 (8.82)	41.96 (9.14)	41.15 (9.36)	42.06 (9.43)	41.73 (9.31)
Unemployment Rate	4.8	4.7	4.7	4.7	4.7
Percent Food Insecure	12.4	12.4	12.4	12.3	12.2
Poverty Rate	12.0	11.9	11.8	11.7	11.7
Median Household Income ($1,000s)[b]	31.28 (0.75)	31.40 (0.74)	31.45 (0.73)	31.47 (0.72)	31.50 (0.71)
Median Welfare Benefit Package ($100s)[b]	5.52 (0.28)	5.57 (0.29)	5.61 (0.29)	5.64 (0.29)	5.65 (0.28)
Minimum Wage ($)[b]	5.43 (0.16)	5.45 (0.17)	5.46 (0.18)	5.47 (0.18)	5.48 (0.18)
Average Democratic Composition of State Governance (i.e. Senate, House of Representatives, Governor)	46.9	46.7	46.6	46.6	46.7

AI/AN, American Indian or Alaskan Native; NHOPI, Native Hawaiian or Pacific Islander

[a]Includes women aged 20 and older

[b]Values are expressed as mean (standard error); clustered on state

[c]Based on 2002 subminimum wage values and 2001 for all others.

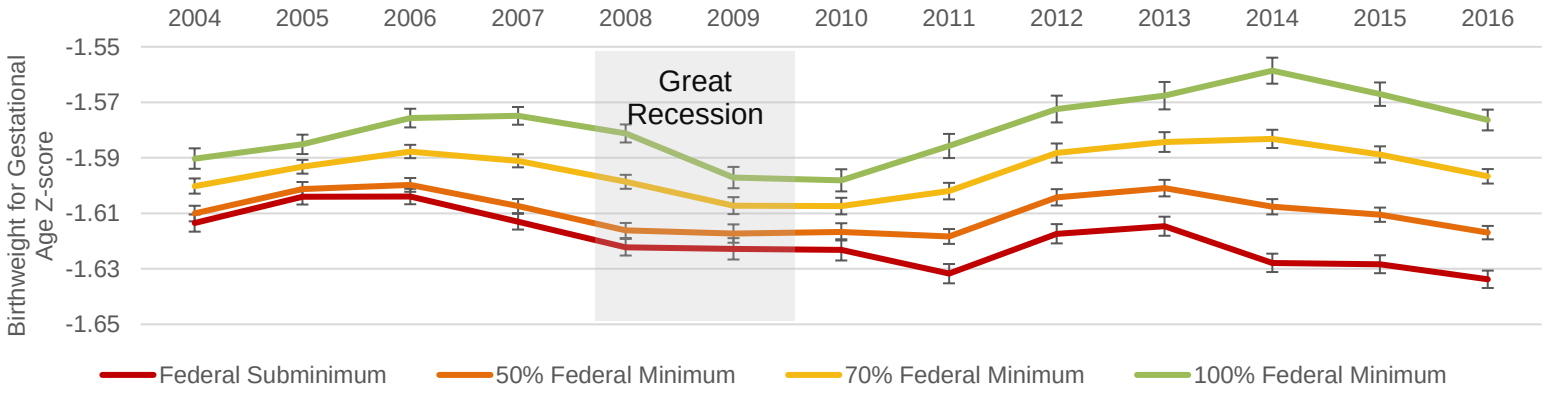
Multivariable Models. We first provide a brief explanation of the quantile regression model results, apply these coefficients to four wage policy scenarios for infants in the smallest and largest quantiles, and then demonstrate the additional change in BWz across the continuum of the BWz distribution attributed to the most effective wage policy (difference-in-differences).

Appendix Table A4.1 displays the coefficients for an illustrative selection of BWz percentiles (5^{th}, 25^{th}, 50^{th}, 75^{th}, and 95^{th} percentiles, among 19 percentiles estimated). The association between change in subminimum wage and infant BWz – indicated by the interactions between subminimum wage and year – differs across the BWz distribution, in effect narrowing the distribution of BWz and shifting it slightly to the left. Notably, for the smallest infants (5^{th} percentile) increases in subminimum wage are associated with an increase in infant BWz (e.g. an increase by 0.005 [95% CI:0.004,0.007] for every dollar above the federal $2.13 in 2016 relative to 2004) while for the largest infants (95^{th} percentile) increases are associated with a reduction in BWz (e.g. a decrease by 0.016 [95% CI:-0.018,-0.015] for every dollar above the federal $2.13 in 2016 relative to 2004). Moreover, the largest increases are observed among the smallest infants and the largest decreases are observed among the largest infants.

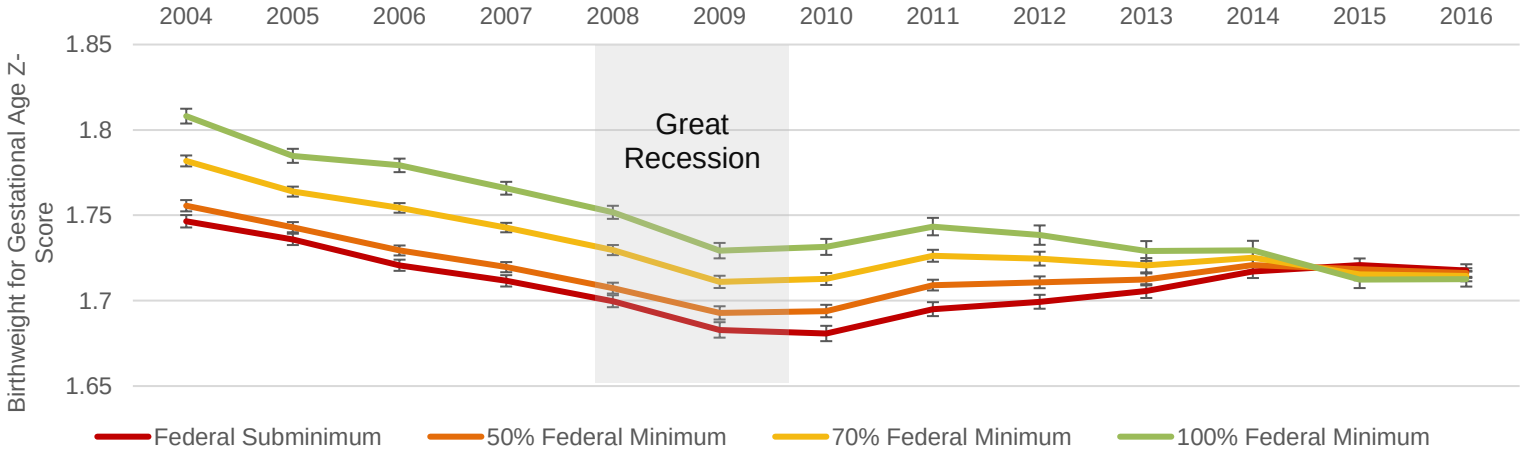
Identifying an effective wage policy intervention. We examined four subminimum wage policy scenarios for the smallest (5th percentile) and largest (95th percentile) infants across the studied period of 2004 to 2016 (**Figure 5.1a-b**). Under all scenarios, changes in predicted BWz are not linear over time, with the largest deviation from linearity spanning 2008 to 2011. For the smallest infants, subminimum wage policy set to the federal subminimum $2.13 (red line) was associated with a net 1.3% decrease in BWz from 2004 to 2014, while wages set to 100% of the federal minimum (green line) were associated with a 1% increase in BWz. For the largest infants, BWz was estimated

Figure 1. Predicted birthweight standardized for gestational age by subminimum wage policy[a] for infants in the (a) smallest quantile and (b) largest quantile, 2004-2016 Vital Statistics Natality Files

a. Infants in the 5th percentile



b. Infants in the 95th percentile

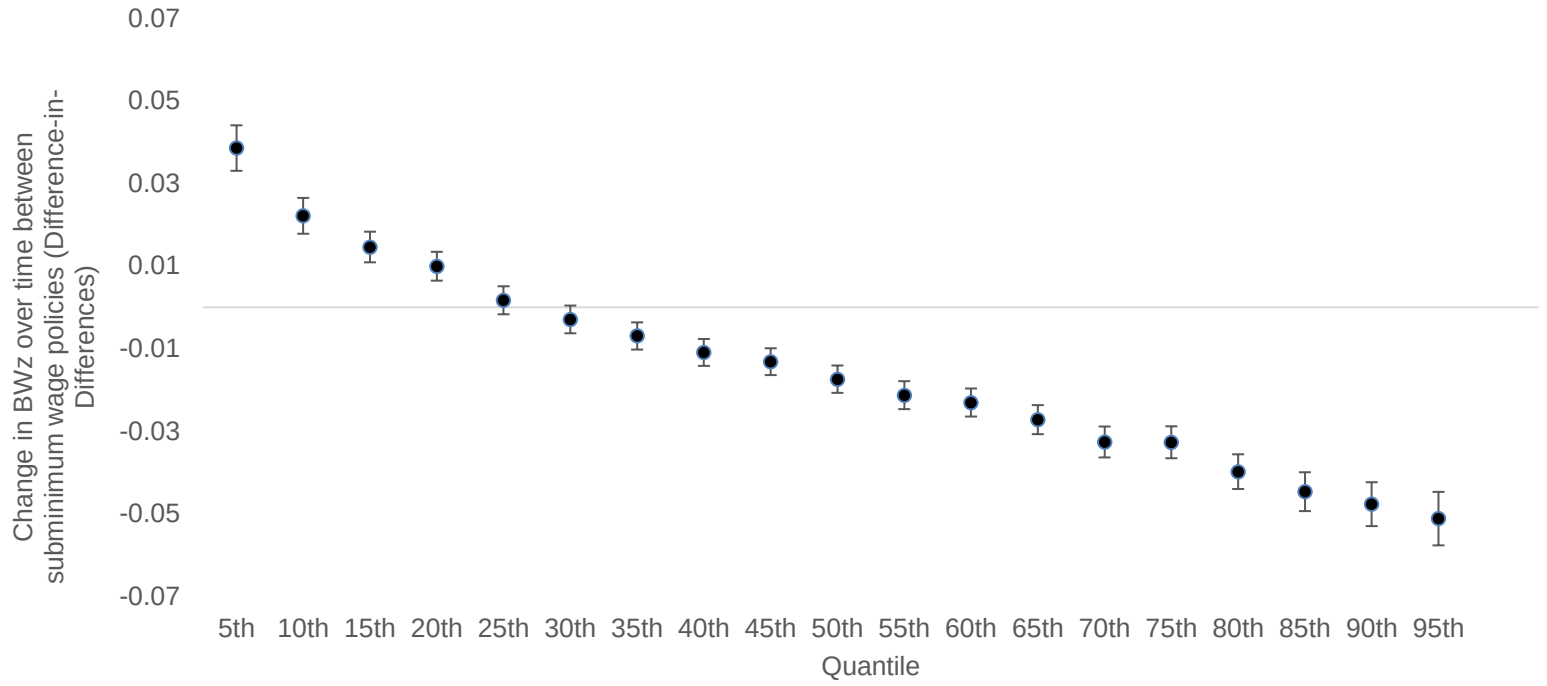


[a]Estimates under four policy scenarios presented with 95% confidence intervals. All models adjust for season, state-level variables lagged three years from infant year and month of birth (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, number in food service occupation, % unemployed, % food insecure, and mean personal income) as well as maternal race/ethnicity, education, age, quadratic age, parity, nativity, marital status and infant sex. Shaded area denotes time period of the 2008 Recession

to decrease by ~3% irrespective of policy scenario from 2004 to 2008, and similarly increase by ~0.5% from 2008 to 2011. However, from 2011 to 2016, subminimum wage policy set to the federal subminimum $2.13 was associated with a 1.3% *increase* in BWz, while wages set to 100% of the federal minimum were associated with a 1.8% *decrease* in BWz among the largest infants. Intermediary policies where subminimum wage was set to 50 to 70% of the minimum wage yielded intermediate effects for both the smallest and largest infants, suggestive of a dose response.

Additional change overtime attributed to the most effective wage policy (difference-in-differences). Using coefficients from the mixed effects models, we estimated the change in infant BWz over time (2004-2016) for the most effective subminimum wage policy – as identified above – relative to the current static subminimum wage all along the continuum of the BWz distribution. In **Figure 5.2,** we compared estimates when subminimum wage remained at $2.13 for the duration of the studied period (Scenario 1) to those when the subminimum wage was set to be the same as the federal minimum wage ($5.15-$7.25; Scenario 4 above). Quantile regression results show that the more generous wage policy is associated with *increased* BW (an increase of 0.039 [95% CI: 0.033, 0.044] BWz) for the smallest infants; and *decreased* BW (a decrease by 0.051 [95% CI: -0.058,-0.045] BWz) for the largest infants. In addition, the BWz distribution shifts slightly to the left, as evidenced by decreases in BWz attributed to the most effective wage policy from the 30^{th} to 95^{th} percentiles. We observed a similar pattern upon restriction to states with consistent availability of maternal educational attainment data (**Appendix Figure 4.3**).

Figure 2. Change in birthweight standardized for gestational age over time (2004-2016) when wage policy is set to 100% federal minimum wage ($5.15 to $7.25) relative to the federal tipped worker subminimum wage (constant $2.13) as estimated in linear quantile mixed effects models[a], 2004-2016 Vital Statistics Natality Files



BWz, Birthweight for gestational age z-score

[a]Estimates are presented for each quantile with 95% confidence interval. All models adjust for season, state-level variables lagged three years from infant year and month of birth (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, number in food service occupation, % unemployed, % food insecure, and mean personal income) as well as maternal race/ethnicity, education, age, quadratic age, parity, nativity, marital status and infant sex.

5.5 DISCUSSION

In this study, we estimated the impact of increasing the state-level subminimum wage on infant BWz across the entirety of the BWz distribution for infants born in the United States 2004-2016. Our results suggest that increasing the state-level tipped worker subminimum wage can promote healthier birthweight in infants, simultaneously increasing BWz of the smallest infants and decreasing BWz of the largest infants. Moreover, the largest estimated potential benefit of subminimum wage increases occur in the tails of the BWz distribution – in which the highest health risks are observed. In our examination of the potential impact of 4 different hypothetical subminimum wage policies, the most conservative policy – maintaining the current federal subminimum wage of $2.13 – is simultaneously associated with further reductions in size for the smallest infants and further increases in size for the largest infants in recent years (2011-2016). The most progressive policy – setting the subminimum wage to the federal minimum wage – was the only strategy that was not associated with increased BWz among the largest infants in recent years (2011-2016).

Our study is the first to examine the implications of state-level tipped worker subminimum wage laws for the health of infants. Our finding that subminimum wage increases may promote healthier birthweight in infants are consistent with those observed in other studies examining the health implications of wage policies aimed at increasing the incomes of working class families.[219] While we present the first examination of the effects of a wage policy across the entirety of the birthweight for gestational age distribution, one study estimated that a $1 increase in the minimum wage would result in 1% decrease in the likelihood of giving birth to a low birthweight infant;[29] another study cited 2,790 fewer low birthweight births annually.[28] One study utilizing quantile regression to examine the effect of another income support – the

earned income tax credit - on birthweight similarly observed larger effects in the left tail of the distribution.[283] Modification of health behaviors, leisure expenditures, and financial stress have been highlighted and evaluated as mechanisms underlying the observed improvements in health in response to wage increases[226] and one previous study found increases in the tipped worker subminimum wage were associated with a reduction in poverty-related stress (**Chapter 4**).

We set out to estimate the impact of a policy that is applied at the state-level on the population as a whole. While fewer than 10% of employed women in the US work in tipped occupations,[3] our examination of the association across the entirety of the BWz distribution enabled us to see that effects were most prominent in the tails, where infants are disproportionately born to women with a higher probability of tipped work exposure as well as differential vulnerability to differential exposure to poverty on account of their race, educational attainment, and marital status[261,284] We observed a narrowing of the distribution and the greatest *increase* in BWz among the smallest infants. In accordance with Geoffrey Rose's population strategy[105], we present evidence that wage policy applied to the whole population may have a larger impact on risk reduction than the application of a high risk approach – and at the very least does not exacerbate inequities.

This study has important limitations. First, we assume that maternal state of residence – and ostensibly employment – two years prior is the same as that reported at the time of infant birth. While migration is differential, fewer than 2% of the US population move from one state to another in a given year.[285] Second, in order to interpret the association for individual infants within a given quantile (versus simply speaking to the changes in the location and dispersion of the distribution), we assume rank similarity;[286] namely that infants stay within a given quantile given their characteristics irrespective of policy

change, or at the very least do not systematically change ranks. However, even if this assumption does not hold, our results still suggest increasing the subminimum wage is associated with a slight leftward shift and narrowing of the BWz distribution. Finally, because income is inversely associated with risk of spontaneous abortion[287] and wage policy and national economic trends impact fertility;[27] there is potential for effects of survival bias, with anticipated bias of our results towards the null. However, the magnitude of bias for conditioning on live births is generally small,[275] and our analyses incorporate individual-level factors that are risk factors of both small or large for gestational age as well as spontaneous abortion.

PUBLIC HEALTH IMPLICATIONS

While economists have long been discussing the implications of minimum wage policy for the economy, public health leaders – and thus considerations for the health of our most vulnerable - are newer to these conversations. Newer still is the consideration of subpopulations – like tipped workers – who are subjected to a subminimum wage because of nuances in the Fair Labor Standards Act. While observed associations in the present study were small, they provide evidence that increasing the subminimum wage – or eradicating the current two-tiered minimum wage system – could simultaneously reduce the burden of being born small or large for gestational age, both of which have ramifications for poor health across the lifecourse. With 82% of the tipped workforce currently employed in states that permit a subminimum wage (33% at the federal $2.13),[3] increasing the subminimum wage is an actionable strategy that may promote healthier birthweight in infants.

CHAPTER 6: Discussion

6.1 Summary

This dissertation represents the first body of research on the health of tipped workers, focusing on reproductive-age women. In the first aim (Chapter 3), the results of my analyses show a greater burden of poor mental health for young women in tipped work relative to similar women in other occupations and point to a handful of differential exposures that may contribute to this finding. In subsequent aims, I go on to investigate one potential intervention that targets differential exposure to poverty in the tipped workforce: raising the subminimum wage. In the second aim (Chapter 4), the results of my analyses suggest that increasing the state-level tipped-worker subminimum wage may reduce poverty-related stress during pregnancy. In the third aim (Chapter 5), the results of my analyses suggest that increasing the state-level tipped-worker subminimum wage may further promote healthier birthweight in infants, simultaneously shifting the location and shrinking the scale of the birthweight for gestational age distribution. In policy simulations, setting the subminimum wage to the full federal minimum wage was the only strategy that was not associated with an increase in poverty-related stress or further dispersion of the distribution of infant birthweight for gestational age in recent years. Collectively, this work provides novel evidence that increasing or eliminating the tipped worker subminimum wage can improve the health of women and their children.

Differential effects across socially-defined groups was a common theme across this dissertation, both in my evaluation of the burden of poor mental health by occupation type and in my assessment of the utility of one potential intervention. Differential effects were observed in both who experienced greater burden of disease as well as who experienced greater benefit of intervention. For instance, while men were also examined in the **Aim 1** manuscript, we observed greater burden of poor health for women in tipped

relative to other occupation types yet associations between tipped work and poor mental health for men were either substantially attenuated or absent. While further research is needed to formerly test the underlying mechanisms driving the observed gender differences, this finding is consistent with my a priori hypotheses related to women's differential vulnerability rooted in acute and chronic experiences of interpersonal and structural sexism. In subsequent aims, I observed the largest potential health promoting impact of increasing the subminimum wage among women with both a higher probability of exposure to tipped work and disproportionately greater risk of consequences. This latter finding is consistent with other research conducted on the health implications of the minimum wage[288] and underscores the importance of examining the effects of even broadly applied policy changes within relevant vulnerable subpopulations.

6.2 Future Research Needs

Given that this dissertation represents the first body of empirical research on the health of tipped workers, there are many questions that remain unanswered. This work investigates the average tipped work experience within one country, one life stage, and explores but one intervention. Further research needs for this topic fall in four domains: the heterogeneity of the tipped work experience, additional vulnerable populations/life stages of interest, additional opportunities for intervention, and implications for future study designs and analyses.

Heterogeneity of the tipped work experience. My dissertation findings may be most reflective of the experience of restaurant servers in the US. In the US, restaurant servers make up the majority of the tipped work force and are also less ambiguously tipped employees – including from a legal standpoint. There are a variety of nuances to the state-level subminimum wage that were beyond the scope of my dissertation, but contribute to differences in who is paid a subminimum wage and how much they are

paid. For instance, at the federal level, a tipped-worker is someone who receives more than $30 per month in tips but in the state of Vermont, it is someone who receives more than $120 per month in tips. As such, whether or not a barista who earns $35 per month in tips would be legally classified as a tipped worker and thus eligible for a subminimum wage varies from one state to the next. Further research is needed to elucidate whether different types of tipped occupations engender different adverse exposures and consequences.

Heterogeneity of the tipped work experience also exists within specific tipped occupations. For instance, the experiences of a waitress in a rural diner are likely different from that of one in an urban fine-dining establishment, and while the former is at greater risk of poverty, they may both suffer the consequences of income volatility. Future studies contrasting these populations may provide further insight in to the role of unpredictable income in the provocation of poor mental health for women in tipped work.

Finally, exploration of international heterogeneity of the tipped work experience in future cross-country comparisons could provide further insight into the drivers of the disproportionate burden of mental health for tipped workers in the US. If disparities persist in countries where all workers are paid living wages and have access to comprehensive social programs, the practice of tipping in particular could be further implicated as a driver of poor health in this population.

Vulnerable populations: Young children. This dissertation includes preliminary evidence that the differential exposures and vulnerabilities of reproductive-aged women in the tipped workforce impact fetal development. What remains to be seen is the postnatal impact of maternal tipped service work – and interventions thereof – on early-life health and development. Relative to mothers in other occupation types, mothers in tipped occupations are disproportionately single[3]. As such, the young children of women

in tipped occupations may be particularly vulnerable to second hits[84] related to their mother's tipped work differential exposures, vulnerabilities, and consequences. In addition to the potential impact of such factors on early-life health, they may contribute to further social stratification within this next generation. As such, it is important to identify potential opportunities to mitigate the intergenerational exacerbation of inequities.

Vulnerable populations: Older women. This dissertation focused on reproductive-aged women. The consequences of tipped work on the health of an aging population is unexplored, especially for those women who spend the majority of their working years in these occupations. The aging population is vulnerable to the potential health consequences of chronic and sustained exposure to low income, income volatility, and harassment. Because of the impact of the tipped minimum wage on lifetime earnings, the association between tipped work-related exposures and poor health may be further modified by low social security payouts. Finally, the restaurant industry is growing faster than health care, construction, or manufacturing in the US;[289] thus, older women with a history of working in tipped service occupations represent an unstudied vulnerable group that is growing in size. From an intervention standpoint, investigation of the association of tipped work with poor health across the lifecourse would allow for the identification of actionable critical periods to mitigate adverse effects, opportunities to interrupt chains of risk, and strategies to decrease the accumulation of risk these vulnerable workers experience in their lifetimes.

Additional opportunities for intervention. In this dissertation, I examine the impact of increasing the tipped worker subminimum wage on maternal and child health, but this is just one of many potential opportunities to intervene on the adverse differential exposures of tipped work. As alluded to above, whether or not the practice of tipping is a driver of poor health for tipped workers is one area requiring further investigation, and

there is need to formally evaluate the impact of “non-gratuity” policies on health. In addition, my descriptive examination of differential exposures by occupation type identified multiple other potential targets for intervention, like access to paid leave. While exposure to last minute schedule changes was not measured in Add Health, this is an exposure of particular interest that – like lack of access to paid leave – is experienced by workers in many occupations, with hypothesized disproportionate exposure for workers in tipped occupations. As such, both paid leave and predictive scheduling represent actionable policy with the potential to improve the health of tipped workers, but also the broader workforce, and those in their care.

Implications for Future Study Designs and Analyses.

Our ability to adequately evaluate the impact of state-level measures, like wage policy, on health is at the mercy of the quality and contents of existing state-level surveillance programs, like PRAMS and NVSS. Of particular importance is the ability to make comparisons between states and within states over time, which requires consistent measurement of survey parameters across state and from one year to the next when possible. In this work, inconsistent measurement of perinatal depression between states and within states over time in PRAMS was a barrier to evaluating the impact of subminimum wage policy on perinatal depression. An additional barrier to studying the impact of state-level measures on the health of the tipped workforce in particular is that occupation information is not routinely collected. Addressing these barriers in future versions of PRAMS, NVSS, and other state-level surveillance programs would enable more robust assessments of actionable public health policy. Moreover, the development of additional content for existing systems and new study cohorts would greatly benefit collaborations with tipped and other precarious workers. These partnerships are critical for elucidating additional barriers to wellness and further opportunities for intervention.

Finally, in future investigations of subminimum wage – and other policies of interest – we must consider the dynamic interplay of the policy change with other policies and shifts in sociodemographic composition. Factors like state-level unemployment can at times confound the relationship between subminimum wage and health and yet mediate the relationship in previous years[290]. In this dissertation, I incorporated these state-level time varying factors as covariates in mixed-effects regression; a formal comparison of these results with those generated using more robust procedures – such as g methods[291] – is an important next step.

6.3 Policy Implications

My dissertation findings suggest that if we increase the tipped worker subminimum wage, we may see a reduction in poverty-related stress and its sequelae for the health of women and their children. And while differential effects were pervasive in both the experience of tipped work and the degree of benefit from increases in subminimum wage, this preliminary evidence suggests at worst no benefit to the least vulnerable and at best greater benefit to the most vulnerable. The observed narrowing of the distribution of birthweight for gestational age as subminimum wage increases is particularly compelling given the implications of being born to small or too big for health across the lifecourse. Notably, while the focus of this work was restricted to the health outcomes of depression and infant birthweight for gestational age, policy aimed at ameliorating poverty and its related stressors can have far-reaching effects on the health and well-being of women and those in their care. As noted throughout, the subminimum wage is but one potential target for intervention and it may not even be the differential exposure with the biggest impact on health. However, minimum and subminimum wages are modifiable and being modified all the time. As such, subminimum wage may be easier to reconcile than other tipped work differential exposures, like deeply culturally ingrained

tipping practices.

At the time of writing these concluding remarks, the 116th Congress has just held their first hearing for H.R. 582, the Raise the Wage Act.[292] This bill includes important language for the tipped workforce. If H.R.582 passes, it would prompt the first federal tipped worker subminimum wage increase in nearly 30 years. Moreover, this proposed amendment to the FLSA includes a plan to gradually raise the wage floor for the tipped workforce in yearly installments until there is no longer a two-tiered minimum wage structure. The fate of this bill in the current political climate is uncertain. In fact, legislation passed last year now permits employers to mandate the inclusion of employees that are paid at least the full minimum wage – such as back of house staff – in tip pools.[178] In addition, new legislation passed in just the past few months now permits employers to pay subminimum wage even when their tipped employees are engaged in non-customer facing activities, such as vacuuming after the restaurant closes for the day.[179] Arguably, US legislation pertinent to the tipped workforce that has passed to date has focused primarily on serving the needs and desires of employers and customers and not the well-being of the workers. While legislative decisions that are counterproductive to the health and well-being of the population are routinely made in spite of substantial evidence, I hold out hope that the previous failure to consider the well-being of the 5 million people working in tipped occupations in the US has simply been a reflection of the paucity of research on this topic.

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Appendix 1. Institutional Review Board Documentation

NOT HUMAN RESEARCH

July 1, 2016

Dear Investigator:

On 7-1-2016, the IRB reviewed the following submission:

Title of Study:	The tipping point: Is there a relationship between tipped worker base wage and adverse birth outcomes?
Investigator:	Janne Heinonen
IRB ID:	STUDY00016159
Funding:	None

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

Certain changes to the research plan may affect this determination. Contact the IRB Office if your project changes and you have questions regarding the need for IRB oversight.

If this project involves the collection, use, or disclosure of Protected Health Information (PHI), you must comply with all applicable requirements under HIPAA. See the HIPAA and Research website and the Information Privacy and Security website for more information.

Sincerely,

The OHSU IRB Office

OREGON HEALTH & SCIENCE UNIVERSITY

IRB MEMO

Research Integrity Office
3181 SW Sam Jackson Park Road - L106RI
Portland, OR 97239-3098
(503)494-7887 irb@ohsu.edu

NOT HUMAN RESEARCH

October 3, 2017

Dear Investigator:

On 10/3/2017, the IRB reviewed the following submission:

Title of Study:	The Tipping Point: An investigation of the effects of subminimum wage on maternal and child health
Investigator:	Janne Heinonen
IRB ID:	STUDY00017693
Funding:	None

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

Certain changes to the research plan may affect this determination. Contact the IRB Office if your project changes and you have questions regarding the need for IRB oversight.

If this project involves the collection, use, or disclosure of Protected Health Information (PHI), you must comply with all applicable requirements under HIPAA. See the HIPAA and Research website and the Information Privacy and Security website for more information.

Sincerely,

The OHSU IRB Office

Appendix 2. Supplemental materials for "Associations of tipped and untipped service work with poor mental health in a nationally representative cohort of adolescents followed into adulthood"

Supplementary Methods and Results

Appendix 2.A. Covariates included in the propensity model.

Sociodemographic variables included Age (Wave IV, continuous), gender (male, female), race (white, black, other), ethnicity (Hispanic, not Hispanic), US nativity (yes, no), and respondent's highest level of education (Wave IV: < high school graduate, high school graduate, some college or vocational training, college graduate).

Parental Characteristics included parent's education (Wave I: < high school graduate, high school graduate, some college or vocational training, college graduate) and parent's income (Wave I, continuous),

Childhood adverse experiences included domains of childhood maltreatment (neglect, emotional abuse, physical abuse, sexual abuse; any affirmative response to Wave III and IV questions pertaining to these domains of maltreatment by parents/caregivers prior to the age 18 was dichotomized), and self-report of any previous history of one or more parent's incarceration (Wave IV; yes, no).

Childhood behaviors included Alcohol Use Disorders Identification Test (AUDIT-C)[293] Score (Wave II, continuous), Tobacco Use (Constructed with tobacco use questions from Waves I and II: Never, former, current), and moderate to vigorous physical activity score (Wave II, continuous),

Childhood health included maximum Center for Epidemiologic Studies Depression (CES-D [294]) Score (Waves I-II; indicative of most depressive symptoms experienced during childhood/adolescence), problems falling or staying asleep (Wave II: Just a few times or less, about once a week, almost every day or more), general health (Wave II: very good or excellent, good, poor or fair), and Body Mass Index (BMI) average (Calculated using physical measurements of height and weight information collected at Waves II and III by Add Health study staff).

Appendix 2.B. Development of Propensity Scores.

Separate PSs were developed for men and women. Because the PSs were used to further restrict the analytic sample and a consistent analytic sample was desired, a single set of PSs were developed for each gender, utilizing a pooled set of theorized confounders and risk factors all study outcomes, rather than generating sets of outcome-specific PSs. Observations from simulation studies suggest that single generic-outcome models reduce bias and maximize precision so long as confounders or risk factors for one exposure-outcome association do not operate as instrumental variables in any of the other exposure-outcome associations being assessed.[295] A conceptual model of the theoretical life-course determinants of each outcome can be found in **Appendix Figure A2.1.** In the propensity model, we included variables in five domains: participant sociodemographics, parental characteristics, and childhood adverse experiences, behaviors, and health (**Appendix 2.A**). This conceptual model was used to guide selection of variables to be included in the propensity model. In accordance with guidance from Brookhart et al. (2006), all theorized confounders and risk factors were included in the propensity model as their inclusion decreases the variance of an estimated exposure effect without increasing bias.[296]

Prior to imputation, 2,832 (31%) respondents were missing 1 or more variable pertinent to PS development. Thus, prior to generating PSs, data were multiply imputed (m=10) and an augmented-regression approach was used to prevent perfect prediction[297] using the augmentation method implemented in Stata software.[298] Within each of the 10 generated complete data sets, multinomial logistic regression was used to model the 3-level (tipped-service, untipped service, and non-service occupations) exposure of interest as a function of all hypothesized and measured risk factors, and confounders. Predicted probabilities (PSs) for each of the three occupation categories were subsequently calculated for each participant, within each of the 10 datasets. The 10 sets of scores were then merged back into the original data set and averaged scores were created for each of the three occupation categories.[299,300] Because the final PSs resulted from the average of 10 models, it was not possible to produce coefficient estimates for the final model of occupation type as a function of all theorized confounders and risk factors. However we present the multiply-imputed and pooled coefficient estimates in **Appendix Table A2.2.**

Appendix 2.C. Propensity Score Distributions and Analytic Sample Range Restriction.

To improve exchangeability and ensure positivity of the analytic sample, we examined PS distributions. Mean, median, standard error, minimum, maximum, percentiles and distributions for each averaged PS were reviewed. The sample was subsequently restricted to individuals with a positive probability for all three occupation categories, as indicated by overlapping regions of PS distributions. Since PSs can only adequately balance factors that are measured, occupation designations contrary to prediction (e.g. working in service occupation despite high propensity for non-service occupation) may indicate unmeasured confounding. Thus, the sample was further restricted using asymmetric trimming.[243] Asymmetrical trimming removed participants who were employed in an occupation type most contrary to prediction. For each occupation type, we utilized cut points at the 5th and 95th percentiles of the PS distribution in the exposed and unexposed participants, respectively.[243]

Appendix 2.D. Incorporation of Propensity Scores in Multivariable Analyses

PS regression adjustment was selected as an approach over matching, weighting, or stratification[242,301] because of (a) software limitations in the simultaneous accommodation of survey design parameters and (b) use of a 3-category exposure variable. Model diagnostics included variable linearity and collinearity assessment, Hosmer-Lemeshow goodness of fit, visual examination of influential points, and the approximate likelihood-ratio test of proportionality of odds for ordinal outcomes.

Appendix 2.E. Assessment of positivity & exchangeability

Six hundred fifty-nine individuals (327 women and 332 men) had propensity scores in regions where not all exposure levels were represented (non-overlapping distributions) and were thus removed due to violation of positivity assumption. A bimodal distribution was observed for propensity of non-service work among women in service work suggestive of unmeasured confounding, particularly for those working in service occupations despite their high propensity for non-service work. While this discrepancy represented a potential violation of the exchangeability assumption, the potential for this violation was visually mitigated following asymmetrical trimming procedures. After asymmetrical trimming, the analytic sample was reduced to 2,815 women and 2,586 men (PS-restricted sample).

Appendix 2 Tables

Appendix Table A2.1. Major Classifications of Service Occupations Stratified by Untipped and Tipped Occupations.

Major Classification 237	Untipped Service Occupations	Tipped Service Occupations [3]
Healthcare Support Occupations	Home Health Aides ; Psychiatric Aides ; Nursing Assistants ; Orderlies ; Occupational Therapy Assistants ; Occupational Therapy Aides ; Physical Therapist Assistants ; Physical Therapist Aides ; Massage Therapists ; Dental Assistants ; Medical Assistants ; Medical Equipment Preparers ; Medical Transcriptionists ; Pharmacy Aides ; Veterinary Assistants and Laboratory Animal Caretakers ; Phlebotomists ; Healthcare Support Workers, All Other	
Protective Service Occupations	First-Line Supervisors of Correctional Officers ; First-Line Supervisors of Police and Detectives ; First-Line Supervisors of Fire Fighting and Prevention Workers ; First-Line Supervisors of Protective Service Workers, All Other ; Firefighters ; Fire Inspectors and Investigators ; Forest Fire Inspectors and Prevention Specialists ; Bailiffs ; Correctional Officers and Jailers ; Detectives and Criminal Investigators ; Fish and Game Wardens ; Parking Enforcement Workers ; Police and Sheriff's Patrol Officers ; Transit and Railroad Police ; Animal Control Workers ; Private Detectives and Investigators ; Gaming Surveillance Officers and Gaming Investigators ; Security Guards ; Crossing Guards ; Lifeguards, Ski Patrol, and Other Recreational Protective Service Workers ; Transportation Security Screeners ; Protective Service Workers, All Other	
Food Preparation and Serving Related Occupations	Chefs and Head Cooks ; First-Line Supervisors of Food Preparation and Serving Workers ; Cooks, Fast Food ; Cooks, Institution and Cafeteria ; Cooks, Private Household ; Cooks, Restaurant ; Cooks, Short Order ; Cooks, All Other; Dishwashers ; Counter Attendant; Combined Food Preparation and Serving Workers, Including Fast Food; Food Preparation Workers; Food Preparation and Serving Related Workers, All Other;	Bartenders; Cafeteria, Food Concession, and Coffee Shop; Waiters and Waitresses; Food Servers Nonrestaurant; Dining room and Cafeteria Attendants and Bartender Helpers; Hosts and Hostesses; Miscellaneous Food Preparation and Serving Related Workers
Building and Grounds Cleaning and Maintenance Occupations	First-Line Supervisors of Housekeeping and Janitorial Workers ; First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers ; Janitors and Cleaners, Except Maids and Housekeeping Cleaners ; Maids and Housekeeping Cleaners ; Building Cleaning Workers, All Other ; Pest Control Workers ; Landscaping and Groundskeeping Workers ; Pesticide Handlers, Sprayers, and Applicators, Vegetation ; Tree Trimmers and Pruners ; Grounds Maintenance Workers, All Other	
Personal Care and Service Occupations	Animal Trainers ; Nonfarm Animal Caretakers ; Gaming and Sports Book Writers and Runners ; Motion Picture Projectionists ; Ushers, Lobby Attendants, and Ticket Takers ; Amusement and Recreation Attendants ; Costume Attendants ; Locker Room, Coatroom, and Dressing Room Attendants ; Entertainment Attendants and Related Workers, All Other ; Embalmers ; Funeral Attendants ; Morticians, Undertakers, and Funeral Directors ; Childcare Workers ; Personal Care Aides ; Fitness Trainers and Aerobics Instructors ; Recreation Workers ; Residential Advisors ; Personal Care and Service Workers, All Other	Gaming Services Workers; Barbers; Hair Dressers, Hairstylists, and Cosmetologists; Makeup Artists, Theatrical and Performance; Manicurists and Pedicurists; Skin Care Specialists; Baggage, Porters, Bellhops, and Concierges;
Transportation and Material Moving Occupations		Taxi Drivers and Chauffeurs

Appendix Table A2.2. Propensity Score Models: Multiply-Imputed Pooled Parameter Estimates

	Women (N=4,996)					Men (N=4,144)				
	Non-Service	*Untipped Service*		*Tipped Service*		*Non-Service*	*Untipped Service*		*Tipped Service*	
		β	95% CI	β	95% CI		β	95% CI	β	95% CI
Age at time of Interview (years)		0.02	-0.04, 0.09	-0.1	-0.20, 0.0		-0.01	-0.09, 0.08	-0.15	-0.34, 0.04
Race (ref: white)										
Black		0.19	-0.14, 0.52	-0.54	-1.11, 0.02		**0.59**	0.22, 0.95	0.41	-0.27, 1.10
Other		-0.01	-0.35, 0.32	-0.23	-0.76, 0.31		-0.07	-0.46, 0.31	0.51	-0.56, 1.58
Hispanic Ethnicity		-0.35	-0.72, 0.03	**-0.62**	-1.23, -0.01		-0.13	-0.61, 0.35	-0.8	-2.30, 0.70
Born outside US		0.74	-0.04, 1.52	-0.6	-1.47, 0.26		0.19	-0.56, 0.94	0.38	-1.71, 2.47
Parent's Education (Wave I; ref: <High School Graduate)										
High School Graduate		**-0.38**	-0.67, -0.08	-0.09	-0.68, 0.51		-0.37	-0.81, 0.07	-0.48	-1.55, 0.59
Some College or Vocational Training		**-0.53**	-0.83, -0.23	0.06	-0.51, 0.62		-0.34	-0.81, 0.13	0.01	-0.96, 0.98
College Graduate		**-0.73**	-1.06, -0.39	-0.01	-0.67, 0.65		-0.22	-0.64, 0.21	0.19	-0.83, 1.21
Parent's Income (Wave I; $)		0	0.00, 0.00	0	0.00, 0.00		0	0.00, 0.00	0	0.00, 0.00
Childhood Maltreatment										
Neglect		0.12	-0.10, 0.34	0.14	-0.21, 0.49		-0.07	-0.33, 0.19	-0.05	-0.64, 0.54
Emotional abuse		-0.06	-0.27, 0.15	-0.31	-0.71, 0.09		-0.07	-0.35, 0.21	0.51	-0.07, 1.08
Physical abuse		**-0.35**	-0.67, -0.03	-0.03	-0.43, 0.37		-0.28	-0.69, 0.14	-0.67	-1.34, 0.00
Sexual abuse		0.24	-0.12, 0.61	-0.47	-1.05, 0.11		0.43	-0.19, 1.04	-0.2	-1.58, 1.17
Incarcerated Parent		**0.35**	0.09, 0.61	0.1	-0.31, 0.51		-0.32	-0.71, 0.07	0.07	-0.60, 0.73
Childhood Highest CES-D Score (Wave I - II)		-0.01	-0.04, 0.03	-0.02	-0.08, 0.03		0.01	-0.04, 0.07	**0.18**	0.08, 0.28
Childhood Problems falling or staying asleep (Wave II; ref: Just a few times or less)	*Ref*					*Ref*				
About once a week		**0.3**	0.02, 0.57	-0.04	-0.49, 0.41		-0.22	-0.59, 0.15	0.13	-0.54, 0.81
Almost every day or more		0.16	-0.17, 0.49	0.11	-0.44, 0.66		-0.16	-0.7, 0.38	-0.19	-1.12, 0.73
Childhood General Health (Wave II; ref: Very good or excellent)										
Good		0.06	-0.16, 0.27	0.05	-0.29, 0.38		0.23	-0.07, 0.53	-0.18	-0.82, 0.45
Poor or Fair		0	-0.39, 0.39	0.03	-0.61, 0.66		0.2	-0.37, 0.76	-0.46	-1.63, 0.70
Childhood AUDIT-C Score (Wave II)		-0.03	-0.07, 0.02	0.03	-0.03, 0.10		-0.01	-0.05, 0.04	0.04	-0.03, 0.11
Childhood Tobacco Use (Wave II; ref: Never)										
Former		0.18	-0.09, 0.45	**0.59**	0.19, 0.98		-0.17	-0.56, 0.22	0.07	-0.58, 0.72
Current		**0.41**	0.12, 0.69	0.39	-0.02, 0.80		-0.23	-0.57, 0.12	0.1	-0.51, 0.70
Childhood Moderate to Vigerous Physical Activity Score (Wave II)		0.01	-0.02, 0.04	0	-0.03, 0.04		0.02	-0.01, 0.06	0.01	-0.06, 0.07
Childhood Average BMI (Wave II - III; kg/m2)		0.01	0.00, 0.03	-0.03	-0.06, 0.01		**0.04**	0.02, 0.06	0	-0.05, 0.05
Highest Level of Education (ref: <High school graduate)										
High School Graduate		**-0.46**	-0.84, -0.08	-0.13	-0.79, 0.53		-0.16	-0.62, 0.30	0.81	-0.65, 2.27
Some College or Vocational Training		-0.23	-0.62, 0.15	0.02	-0.62, 0.66		0	-0.38, 0.39	**1.5**	0.23, 2.77
College Graduate		**-1.54**	-1.98, -1.11	**-1.86**	-2.71, -1.00		-0.86	-1.33, -0.39	**0.16**	-1.48, 1.80

Appendix Table A2.3. Major Occupation Group in the Propensity Score-Restricted Sample (N=5,401) Stratified by Gender, National Longitudinal Study of Adolescent Health, 1994-2008

BLS Major Occupation Group	Total, %	Women,%	Men,%
Sales and Related	12.04	13.9	10.32
Office and Administrative Support	8.96	15.83	2.58
Food Preparation and Serving Related	8.88	10.5	7.37
Construction and Extraction	7.62	0.4	14.33
Management	7.08	6.23	7.88
Production	6.90	3.85	9.74
Healthcare Support	6.87	12.21	1.91
Education, Training, and Library	5.38	8.20	2.75
Business and Financial Operations	5.14	6.00	4.35
Installation, Maintenance, and Repair	4.91	0.46	9.03
Transportation and Material Moving	4.31	1.20	7.19
Healthcare Practitioners and Technical	3.59	6.00	1.36
Protective Service	3.36	1.48	5.10
Personal Care and Service	2.90	4.97	0.99
Computer and Financial Operations	2.72	0.91	4.41
Arts, Design, Entertainment, Sports, and Media	2.46	2.09	2.8
Building and Grounds Cleaning and Maintenance	2.26	1.30	3.16
Community and Social Service	1.51	2.11	0.95
Architecture and Engineering	1.01	0.34	1.63
Farming, Fishing, and Forestry	0.84	0.50	1.16
Legal	0.68	0.95	0.42
Life, Physical, and Social Science	0.57	0.56	0.59

Abbreviations: BLS, Bureau of Labor Statistics
Percentages are calculated by accounting for survey weights, strata, and clusters

Appendix Table A2.4. Occupation of Tipped Service Workers in the Propensity Score-Restricted Sample (N=280) Stratified by Gender, National Longitudinal Study of Adolescent Health, 1994-2008

Occupation	Total, %	Women, %	Men, %
Waiters and Waitresses	40.6	44.3	30.8
Bartenders	19.1	13.7	33.6
Barbers, Hairdressers, Hairstylists, and Cosmetologists	16.8	18.0	13.4
Personal Care and Service Workers, All Other	10.1	9.4	11.9
Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	5.5	5.7	4.9
Dining Room and Cafeteria Attendants and Bartender Helpers	2.0	2.7	0.0
Massage Therapists	1.4	0.7	3.4
Skincare Specialists	1.2	1.6	0.0
Transportation Attendants, Except Flight Attendants and Baggage Porters	1.1	1.5	0.0
Gaming Dealers	1.0	0.6	1.8
Manicurists and Pedicurists	0.8	1.2	0.0
Entertainment Attendants and Related Workers, All Other	0.4	0.6	0.0
Concierges	0.1	0.1	0.2

Percentages are calculated by accounting for survey weights, strata, and clusters.

Appendix Table A2.5. Occupation Characteristics of 2,815 Women and 2,586 Men in the Propensity Score-Restricted Sample by Occupation Type, National Longitudinal Study of Adolescent Health, 1994-2008

Parameters	Women (N=2,815)			Men (N=2,586)		
	Non-Service, %	Untipped Service, %	Tipped Service, %	Non-Service, %	Untipped Service, %	Tipped Service, %
Time at current job (years)[a]	3.2 (0.1)	3.2 (0.2)	3.2 (0.3)	3.1 (0.1)	2.9 (0.2)	2.8 (0.4)
Hours worked per week[a]	39.3 (0.3)	35.8 (0.6)	32.4 (0.9)	44.8 (0.4)	42.1 (0.9)	35.2 (1.3)
Average hourly wage (dollars)[a,b]	12.79 (0.39)	9.70 (0.46)	10.66 (0.77)	17.78 (0.61)	14.61 (0.77)	18.24 (2.80)
Shift Type						
Regular days, nights, or evenings	81.0	77.3	66.0	79.6	67.4	73.0
Rotating schedule	8.8	12.4	14.9	6.3	15.8	14.1
Split or otherwise irregular	10.2	10.4	19.1	14.1	16.9	13.0
Employer provides health insurance	74.4	61.2	34.3	73.5	73.3	53.7
Employer offers sick/vacation time	76.5	63.9	32.6	72.1	68.6	39.5
Job Time Spent…						
Standing, hard physical work	3.2	7.5	6.7	28.3	20.4	9.9
Standing, moderate physical work	18.2	45.8	57.0	20.9	34.9	28.6
Standing, light physical work	26.7	28.5	30.5	17.3	21.7	52.1
Seated	51.9	18.2	5.9	33.5	23.0	9.3
Freedom to make important decisions						
None of the time	9.7	12.0	16.3	8.0	6.7	10.7
Some of the time	26.6	29.9	30.2	22.7	23.2	42.5
Most of the time	34.4	34.9	27.0	33.7	33.0	18.3
All of the time	29.3	23.2	26.6	35.6	37.1	28.5

Percentages, means, and standard errors are calculated by accounting for survey weights, strata, and clusters.

[a]Values are expressed as mean (standard error)

[b]Personal earnings before taxes (wages or salaries, including tips, bonuses, and overtime pay, and income from self-employment) divided by 52*average hours worked per week

Appendix Table A2.6. Mental Health Outcomes Regressed on Employment Category in Women and Men who Reported a Current or Recent Job During the Wave IV interview, National Longitudinal Study of Adolescent Health, 1994-2008

	Depression		Sleep Problems		Higher Perceived Stress Tertile	
	OR	***95%CI***	***OR***	***95%CI***	***OR***	***95%CI***
Unrestricted Women (N=4,996)[a]						
Non-Service	Referent		Referent		Referent	
Untipped Service	1.27	0.99, 1.64	**1.54**	**1.10, 2.14**	1.18	0.96, 1.44
Tipped Service	**1.87**	**1.27, 2.74**	1.33	0.90, 1.97	**1.51**	**1.15, 1.97**
Unrestricted Men (N=4,144)[a]						
Non-Service	Referent		Referent		Referent	
Untipped Service	1.24	0.84, 1.84	1.03	0.64, 1.63	1.06	0.80, 1.41
Tipped Service	0.91	0.44, 1.91	0.71	0.30, 1.67	1.23	0.83, 1.84
	RR	***95%CI***	***RR***	***95%CI***		
Women, PS-Restricted Sample[b] (N=2,815)						
Non-Service	Referent		Referent			
Untipped Service	1.16	0.95, 1.41	1.27	0.93, 1.74		
Tipped Service	**1.38**	**1.09, 1.75**	1.39	0.99, 1.94		
Men, PS-Restricted Sample[c] (N=2,586)						
Non-Service	Referent		Referent			
Untipped Service	1.21	0.86, 1.71	0.88	0.54, 1.43		
Tipped Service	0.82	0.35, 2.02	1.2	0.55, 2.62		

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test; BMI, Body Mass Index; CES-D, Center for Epidemiologic Studies Depression Scale; CI, Confidence Interval; OR, Odds Ratio; PS, Propensity Score; RR, Relative Risk; US, United States

[a]Confounding adjusment included: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score. Multiply Imputed.

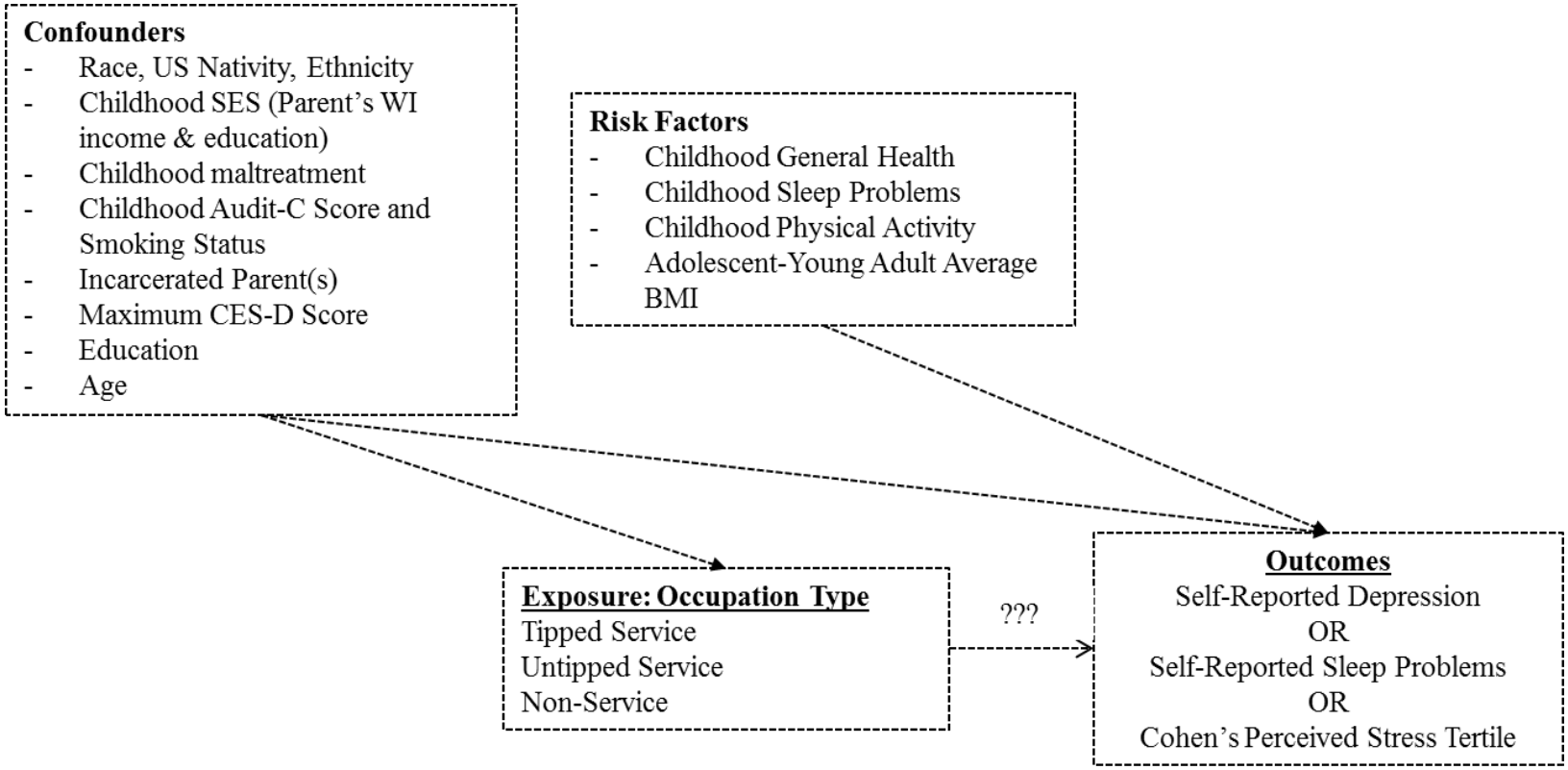
[b]Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS, race, parental educational attainment, and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

[c]Overlapping asymmetrically trimmed propensity distributions, Adjusted for PS and participant educational attainment. PSs include the following variables: race, whether or not born in US, highest level of education attained, Parent's highest level of education and Wave I household income, childhood maltreatment, incarcerated parent, Max childhood CES-D score, Childhood smoking history, childhood AUDIT-C score, childhood general health, childhood sleep, rolling average BMI, and childhood physical activity

[d]Tipped service workers significantly different relative to untipped service workers

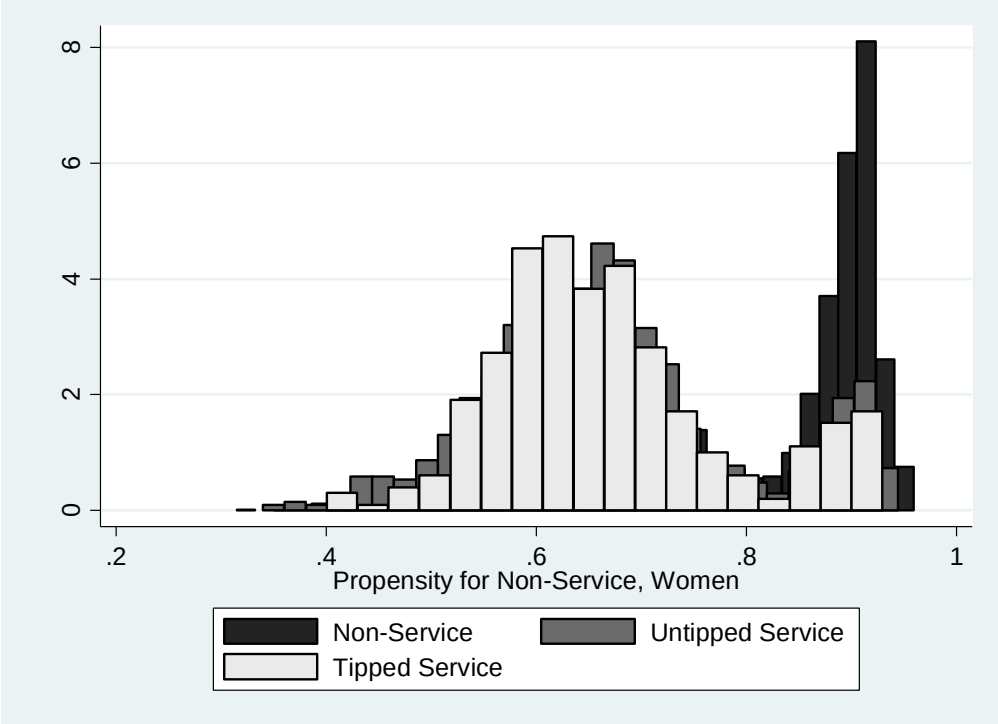
Appendix 2 Figures

Appendix Figure A2.1. Conceptual Model

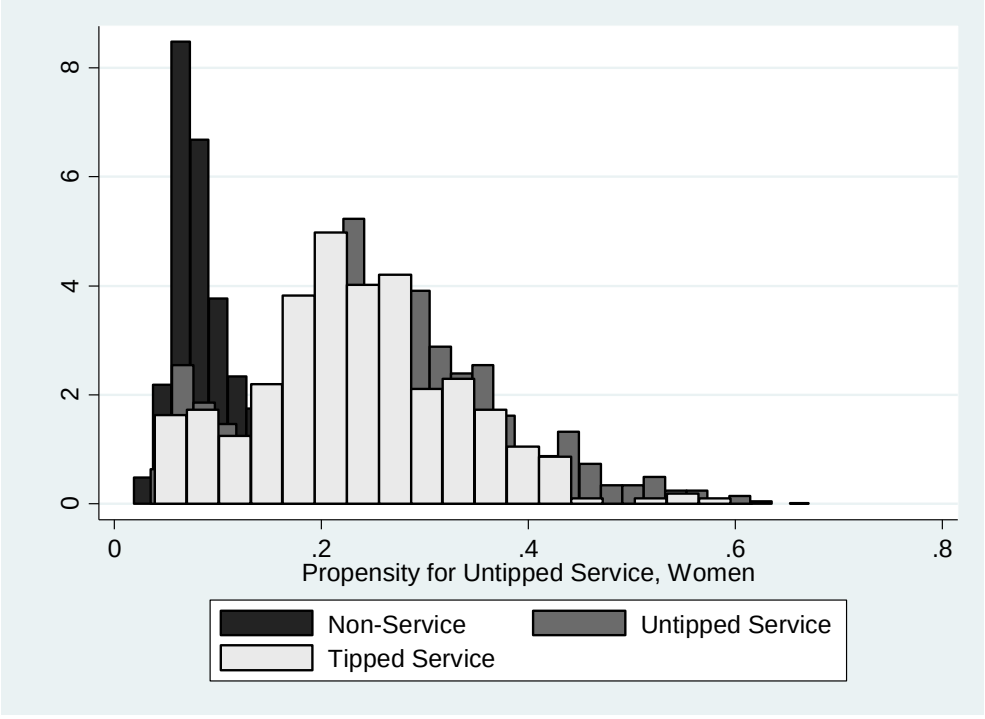


Appendix Figure A2.2. Untrimmed multiply-imputed propensity score distributions for 4,996 women

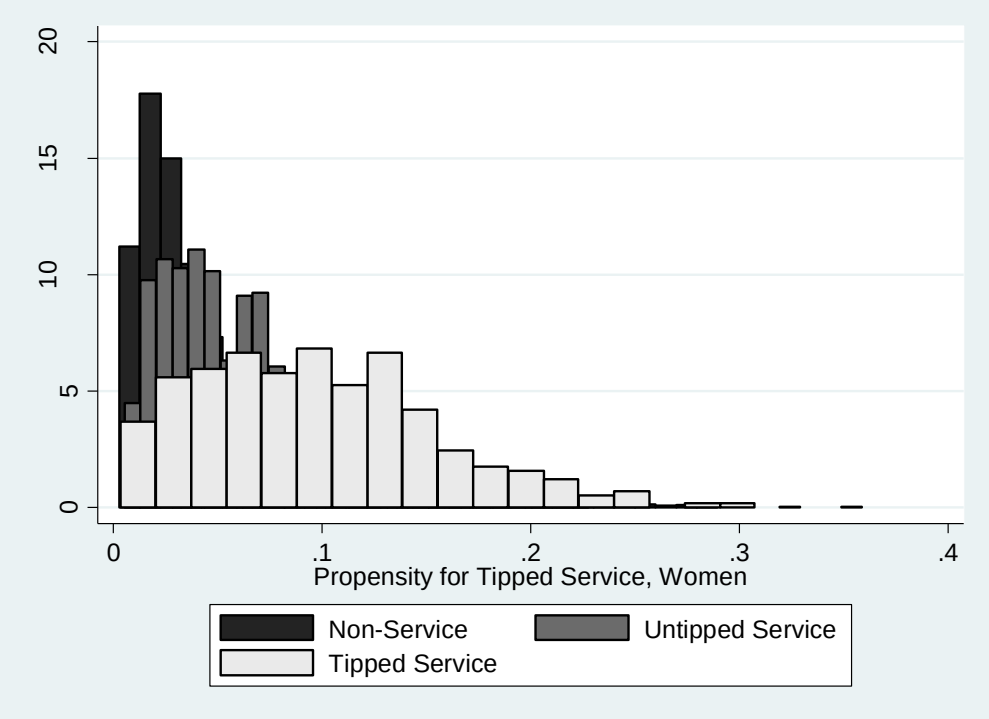
A. Conditional Probability of Working in a Non-Service Occupation:



B. Conditional Probability of Working in an Untipped Service Occupation:

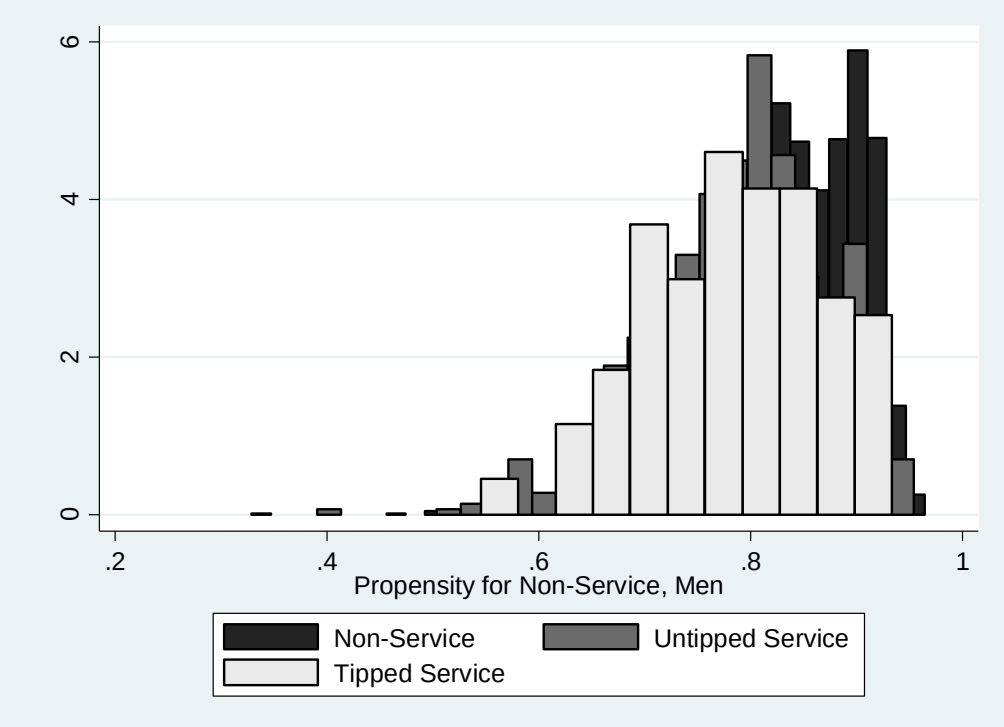


C. Conditional Probability of Working in Tipped Service Occupation:

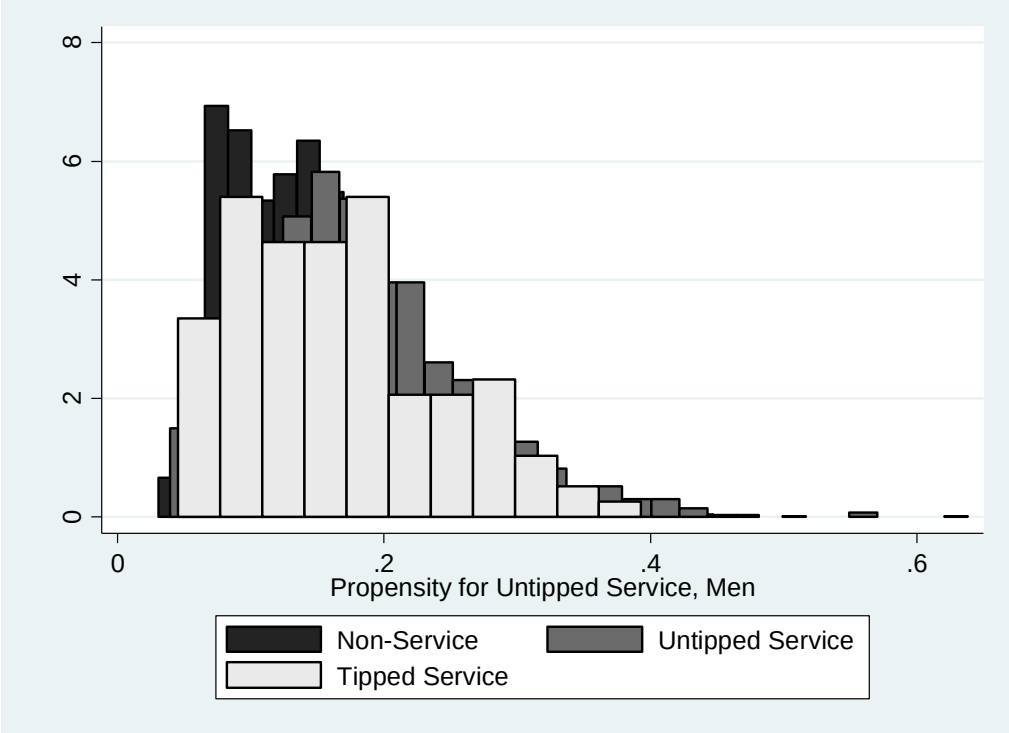


Appendix Figure A2.3. Untrimmed multiply-imputed propensity score distributions for 4,144 men.

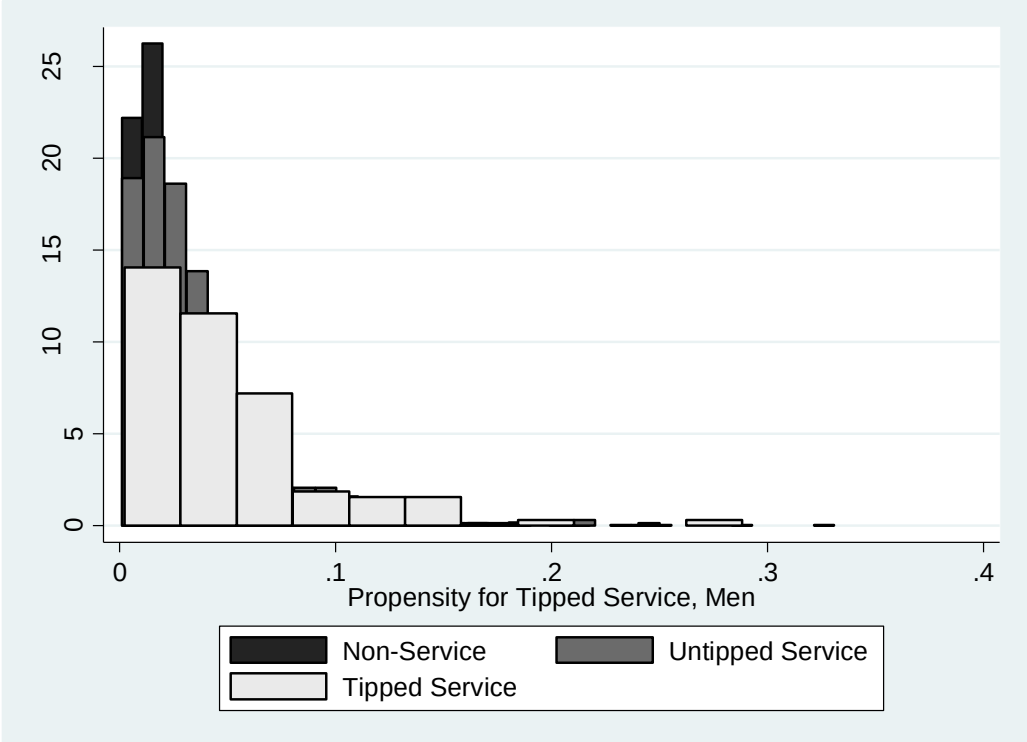
A. Conditional Probability of Working in a Non-Service Occupation:



B. Conditional Probability of Working in an Untipped Service Occupation:



C. Conditional Probability of Working in Tipped Service Occupation:



Appendix 3. Supplemental materials for "The Tipping Point: Could increasing the subminimum wage reduce poverty-related antenatal stressors in US women?"

Supplementary Methods and Results

Appendix 3.A. Description of statistical model

We utilized mixed effects linear regression to adjust for confounding and autocorrelation. Our simplified equation is as follows:

$$\begin{aligned}\text{Eq. (C1): } S_{st} = {} & \beta_0 + \beta_1 Phase5_t + \beta_2 Phase6_t + \beta_3 Phase7_t + \beta_4 SW_{st} \\ & + \beta_5 Phase5_t * SW_{st} + \beta_6 Phase6_t * SW_{st} + \beta_7 Phase7_t * SW_{st} \\ & + \beta_8 Seasonality_t + \beta_9 P_{st} + \beta_{10} X_{st} + b_{1s} + b_2 Phase5_{st} + b_3 Phase6_{st} \\ & + b_4 Phase7_{st} + \epsilon_{st}\end{aligned}$$

Where S_{st} denotes the mean number of cumulative poverty-related antenatal stressors occurring in state *s* and year-months *t*. Continuous time was divided into three separate slopes to address a non-linear relationship between time and cumulative poverty-related stress; disruptions to the linear trend were temporally consistent with shifts in PRAMS data collection phases. SW is the subminimum wage in state *s* and year-months *t*. We accounted for seasonality with a four level categorical variable of annual quarters (January – March, April – June, July – September, October – December). P_{st} is a vector of time-varying state-level characteristics and X_{st} is a vector of state-month averaged individual level characteristics. b_{1s} denotes random baseline state differences and $b_2 Phase5_{st}$, $b_3 Phase6_{st}$, and $b_4 Phase7_{st}$ denote random changes within states over time to address unmeasured time-varying state-level factors.

We estimated variance with robust sandwich estimators and bootstrapping procedures. Both methods produced similar estimates; results with robust sandwich estimators are reported to enable reporting of the Wald Chi value.

Appendix 3.B. Multivariable models

After accounting for exogenous changes in sociodemographic composition and policy environment over time, the mean number of reported poverty-related stressors decreased from 2004 to 2014 for women both with and without a college degree (**Appendix Table A3.2)**. Among women with less than a college degree, there was an association between increasing the subminimum wage and reduced stress over time, though not significant on average. However, significant differences were observed in samples further restricted to a subgroup of women who were both more likely to be exposed to tipped work and to experience adverse effects. Among non-White or Hispanic unmarried multiparous women with less than a college degree, for every $1 increase in subminimum wage there were 13 fewer stressors per month per 1,000 women from 2004 to 2008 (β: -0.013; 95% Confidence Interval:-0.023,-0.004), a smaller monthly decrease from 2009 to 2011 (β:-0.031; 95% Confidence Interval:0.009,0.053), and a larger monthly decrease from 2012 to 2014 (β: -0.035; 95% Confidence Interval:-0.062,-0.008). In examination of visual model diagnostics, the statistical model was robust to deviations from normality and the assumption of parallel trends was satisfied (**Appendix Figure A3.2**).

Appendix 3 Tables

Appendix Table A3.1. Data availability and subminimum wage change over time by state

State	Hourly wage ($) in base year (2003)	Change in Subminimum Wage from Previous Year*										Included in Final Analytic Sample?
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
AK	7.15	•	•	•	•	•	↑	--	•	•	•	Y
AL	2.13	--	--	--	--	--	--	--	--	--	•	N
AR	2.58	•	•	↑	•	•	•	•	•	•		Y
AZ	2.13											N
CA	6.75											N
CO	2.13	•	•	•	↑	↑	↑	↓	↑	↑	--	Y
CT	4.88									--	•	N
DE	2.23			•	•	•	•	•	•	•	•	Y
FL	2.13	•		--	--	--	--	--	--	--	--	Y
GA	2.13	•	•	•	•	•	•	•	•	•	--	Y
HI	6.00	•	•	↑	↑	•	•	•	•	•	•	Y
IA	3.09									•	•	Y
ID	3.35											N
IL	3.09	↑	↑	•	↑	↑	↑	↑	•	•	•	Y
IN	2.13											N
KS	3.09											N
KY	2.13											N
LA	2.13		--	--	--	--	--	--	--	--	--	N
MA	2.63			•	•	•	•	•	•	•	•	Y
MD	2.38	•	•	↑	•	↑	↑	•	•	•	•	Y
ME	3.13	↑	↑	↑	↑	↑	↑	•	•	•	•	Y
MI	2.65	•	•	•	•	•	•	•	•	•	--	Y
MN	5.15	•	↑	•	•	•	•	•	•	•		Y
MO	2.58			•	--	↑	↑	•	•	•	•	Y
MS	2.13		•	--	•	•	--	--	--	--	--	Y
MT	5.15											N
NC	2.13	•	--	•	•	--	--	--	--	--	--	Y
ND	3.45											N
NE	2.13	•	•	•	•	•	•	•	•	•	•	Y
NH	2.32									•	•	Y
NJ	3.09	•	↑	↓	•	•	•	•	•	•	•	Y
NM	2.13	•	--	--	--	--	--	•	•	•	•	Y
NV	5.15											N
NY	3.30	•	↑	↑	↑	--	↑	•	↑	•	•	Y
OH	2.13	•	•	•	↑	↑	↑	--	↑	--	↑	Y
OK	2.58	•	•	•	↑	↑	↑	•	•	•	•	Y
OR	6.90	↑	↑	↑	↑	↑	↑	•	↑	↑	--	Y
PA	2.83			•	•	•	•	•	•	•	•	Y
RI	2.89	•	•	•	•	•	•	•	•	•	•	Y
SC	2.13	•	•	•	--	--	--	--	--	--	--	Y
SD	2.13											N
TN	2.13			--	•	•	--	--	•	•	•	Y
TX	2.13	--	--	--	--	◊	◊	--	--	--	--	N
UT	2.13	•	•	•	•	•	•	•	•	•	•	Y
VA	2.13											N
VT	3.44	↑	↑	•	•	↑	↑	•	↑	↑	↑	Y
WA	7.01	↑	↑	↑	↑	↑	↑	•	↑	↑	↑	Y
WI	2.33			•	•	•	--	•	•	•	•	Y
WV	4.12	•	•	↑	↑	↑	•	•	•	•	•	Y
WY	2.13			•	•	•	•	•	•	•	•	Y

*Subminimum wage is lagged by one year (e.g. 2003 wages for 2004 PRAMS data)
↑: Data available, increase in wage from previous year
↓: Data available, decrease in wage from previous year
•: Data available, no change in wage from previous year
◊: Data unavailable, meets CDC response rate threshold for the year but declined by state
--: Data is unavailable, did not meet response rate threshold for the year

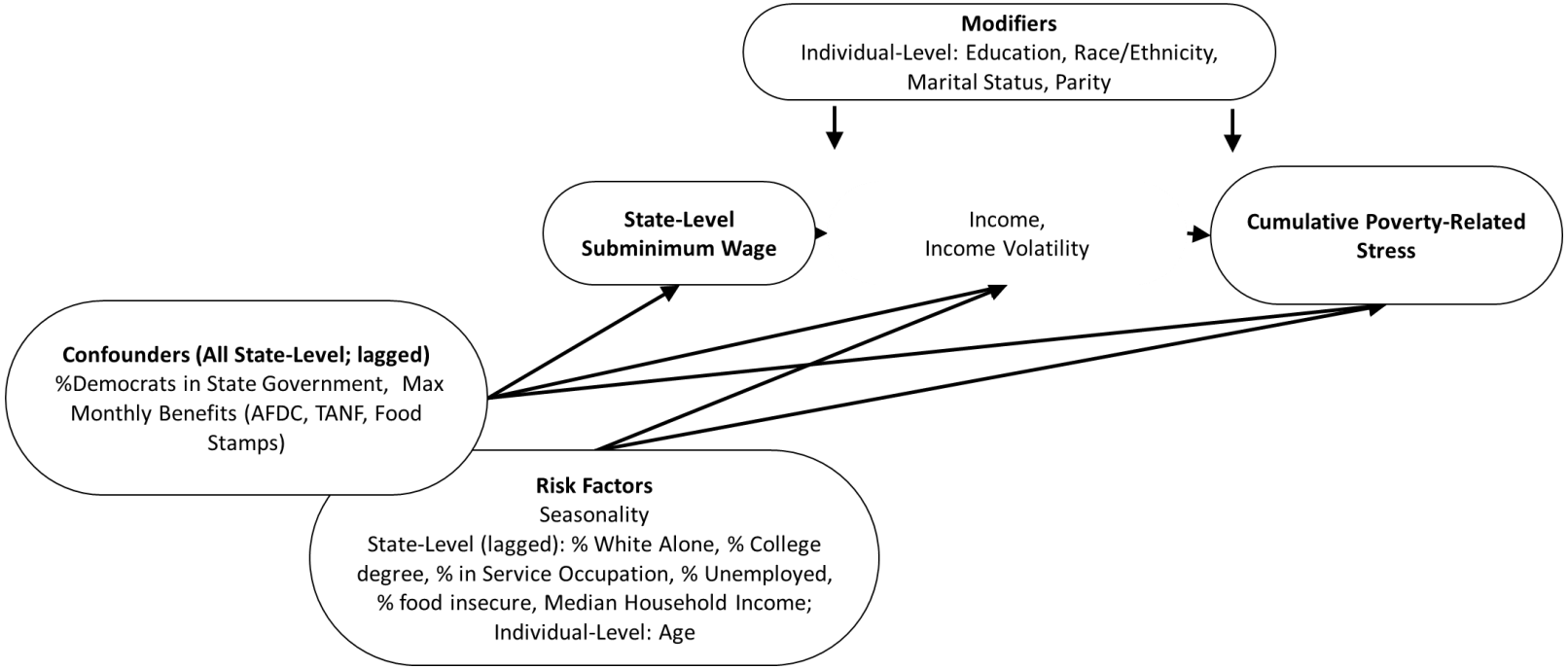
Appendix Table A3.2. Estimated[a] annual effects of state-level subminimum wage on cumulative reported poverty-related antenatal stressors, PRAMS 2004-2014

	N[b]	N[c]	Phase 5 (2004 - 2008)	Phase 6 (2009 - 2011)	Phase 7 (2012 - 2014)	Wald chi2[d]
			β (95% CI)			
Main Effects of Change in Subminimum Wage on Number of Poverty Related Stressors[e]						
≥ College Degree	3,388	119,511	0.001 (-0.001,0.004)	0.002 (-0.004,0.008)	-0.008 (-0.020,0.004)	2352.23
< College Degree	3,389	245,077	-0.002 (-0.006,0.002)	0.005 (-0.003,0.013)	-0.015 (-0.030,0.001)	2356.89
Vulnerable Subgroup Analyses (All <College Degree)						
Race/Ethnicity[f]						
White Women	3,388	122,175	0.001 (-0.005,0.007)	0.002 (-0.010,0.014)	-0.014 (-0.034,0.005)	1668.03
Nonwhite Women	3,360	122,902	**-0.006 (-0.011,-0.001)**	0.019 (-0.000,0.038)	**-0.031 (-0.061,-0.001)**	4294.00
Marital Status[g]						
Married	3,389	131,651	0.002 (-0.001,0.006)	-0.003 (-0.013,0.007)	-0.007 (-0.022,0.008)	3691.06
Unmarried	3,388	113,426	-0.008 (-0.016,0.000)	**0.019 (0.006,0.032)**	**-0.028 (-0.051,-0.005)**	1026.54
Parity[h]						
Nulliparous	3,389	82,947	-0.003 (-0.006,0.003)	0.011 (-0.002,0.021)	**-0.030 (-0.052,-0.008)**	840.01
Multiparous	3,389	161,088	-0.001 (-0.006,0.004)	0.003 (-0.005,0.011)	-0.010 (-0.021,0.002)	3158.37
Unmarried Nonwhite Multiparous Women[i]	3,227	42,296	**-0.013 (-0.023,-0.004)**	**0.031 (0.009,0.053)**	**-0.035 (-0.062,-0.008)**	440.21

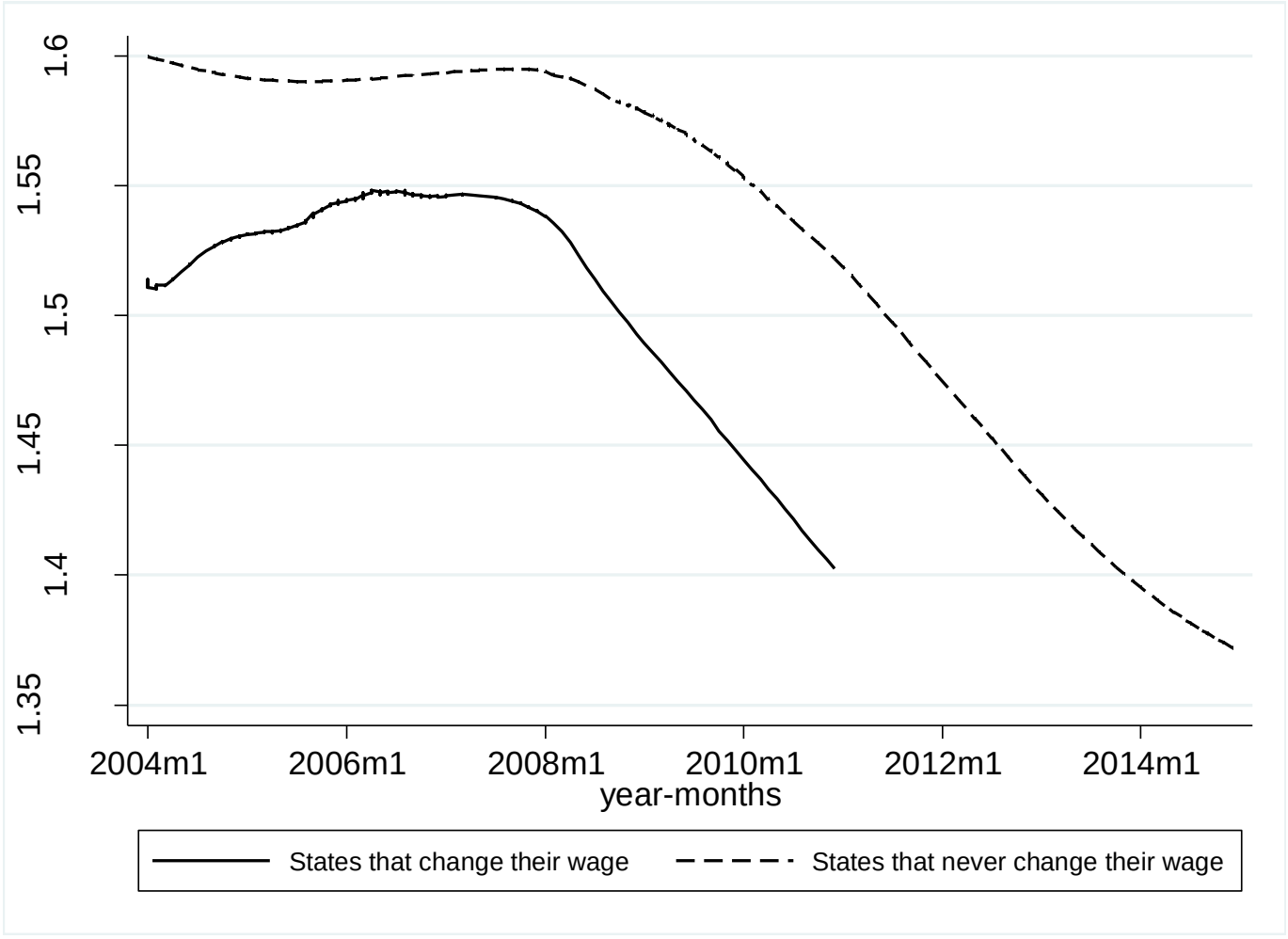
[a]All models adjust for state-level variables lagged two years from PRAMS outcome ascertainment (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, % in service occupation, % unemployed, % food insecure, and median household income.
[b]Number of state-months included in analysis
[c]Total number of PRAMS participants included in the calculation of state-month averages
[d]For the overall model; all p-values<0.00001
[e]Models include addition adjustment for state-month mean of the following PRAMS variables: % black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % married, % multiparous
[f]Models include addition adjustment for state-month mean of the following PRAMS variables: maternal age, % married, % multiparous
[g]Models include addition adjustment for state-month mean of the following PRAMS variables: % black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % multiparous
[h]Models include addition adjustment for state-month mean of the following PRAMS variables: % black, % Asian, %American Indian, Native Hawaiian, Alaska Native, or Pacific Islander, % Hispanic, % Not White Race (specific unknown), maternal age, % married
[i]Models include addition adjustment for state-month mean of the following PRAMS variables: maternal age

Appendix 3 Figures

Appendix Figure A3.1. Conceptual framework; hypothesized relationship between study measures



Appendix Figure A3.2. Model-based trend of estimated mean poverty-related stressors prior to policy change



Appendix 4. Supplemental materials for "A Nationwide Investigation of the Impact of the Tipped Worker Subminimum Wage on Infant Size for Gestational Age"

Supplementary Methods

Appendix 4.A. Description of statistical model

Quantiles were defined prior to multivariable regression by transforming the dependent variable with the recentered influence function (RIF) as follows:

$$RIF(Y; q_\tau, F_Y) = q_\tau + \frac{(\tau - 1\{Y \leq q_\tau\}}{f_Y(q_\tau)}$$

Where τ denotes a given quantile, q_τ is the value of birthweight for gestational age Z-score, Y, at the τth quantile. $f_Y(q_\tau)$ denotes the density of Y at q_τ and F_Y is the cumulative distribution function of Y. Finally, the indicator function $1\{Y \leq q_\tau\}$ creates a dummy variable set to 1 if a given infant's birthweight for gestational age is below τ. We estimated RIF for $\tau = 5 - 95$ in intervals of 5 (e.g. 5, 10,…,95) utilizing the Stata user developed rifreg command;[302] models included the outcome, size for gestational age z-score, only.

We subsequently utilized the transformed dependent variable in mixed effects linear regression models. Separate regression models were run for each quartile. Our simplified equation is as follows:

$$\begin{aligned} Y_{ist} = {} & \beta_0 + \beta_1 Yr2005_t + \beta_2 Yr2006_t + \beta_3 Yr2007_t + \beta_4 Yr2008_t + \beta_5 Yr2009_t + \beta_6 Yr2010_t \\ & + \beta_7 Yr2011_t + \beta_8 Yr2012_t + \beta_9 Yr2013_t + \beta_{10} Yr2014_t + \beta_{11} Yr2015_t \\ & + \beta_{12} Yr2016_t + \beta_{13} SW_{st} + \beta_{14} Yr2005_t * SW_{st} + \beta_{15} Yr2006_t * SW_{st} \\ & + \beta_{16} Yr2007_t * SW_{st} + \beta_{17} Yr2008_t * SW_{st} + \beta_{18} Yr2009_t * SW_{st} \\ & + \beta_{19} Yr2010_t * SW_{st} + \beta_{20} Yr2011_t * SW_{st} + \beta_{21} Yr2012_t * SW_{st} \\ & + \beta_{22} Yr2013_t * SW_{st} + \beta_{23} Yr2014_t * SW_{st} + \beta_{24} Yr2015_t * SW_{st} \\ & + \beta_{25} Yr2016_t * SW_{st} + \beta_{26} Seasonality_t + \beta_{27} P_{st} + \beta_{28} X_{st} + b_{1s} + \epsilon_{st} \end{aligned}$$

Where Y_{ist} denotes the recentered birthweight for gestational age Z-score for infant i in state *s* and year *t*. Categorical indicators for each year were included to address a non-linear relationship between time and birthweight for gestational age. SW is the subminimum wage in state *s* and year-months *t*. We accounted for seasonality with a four level categorical variable of annual quarters (January – March, April – June, July – September, October – December). P_{st} is a vector of time-varying state-level characteristics and X_{ist} is a vector individual level characteristics. b_{1s} denotes random baseline state differences.

Appendix 4 Tables

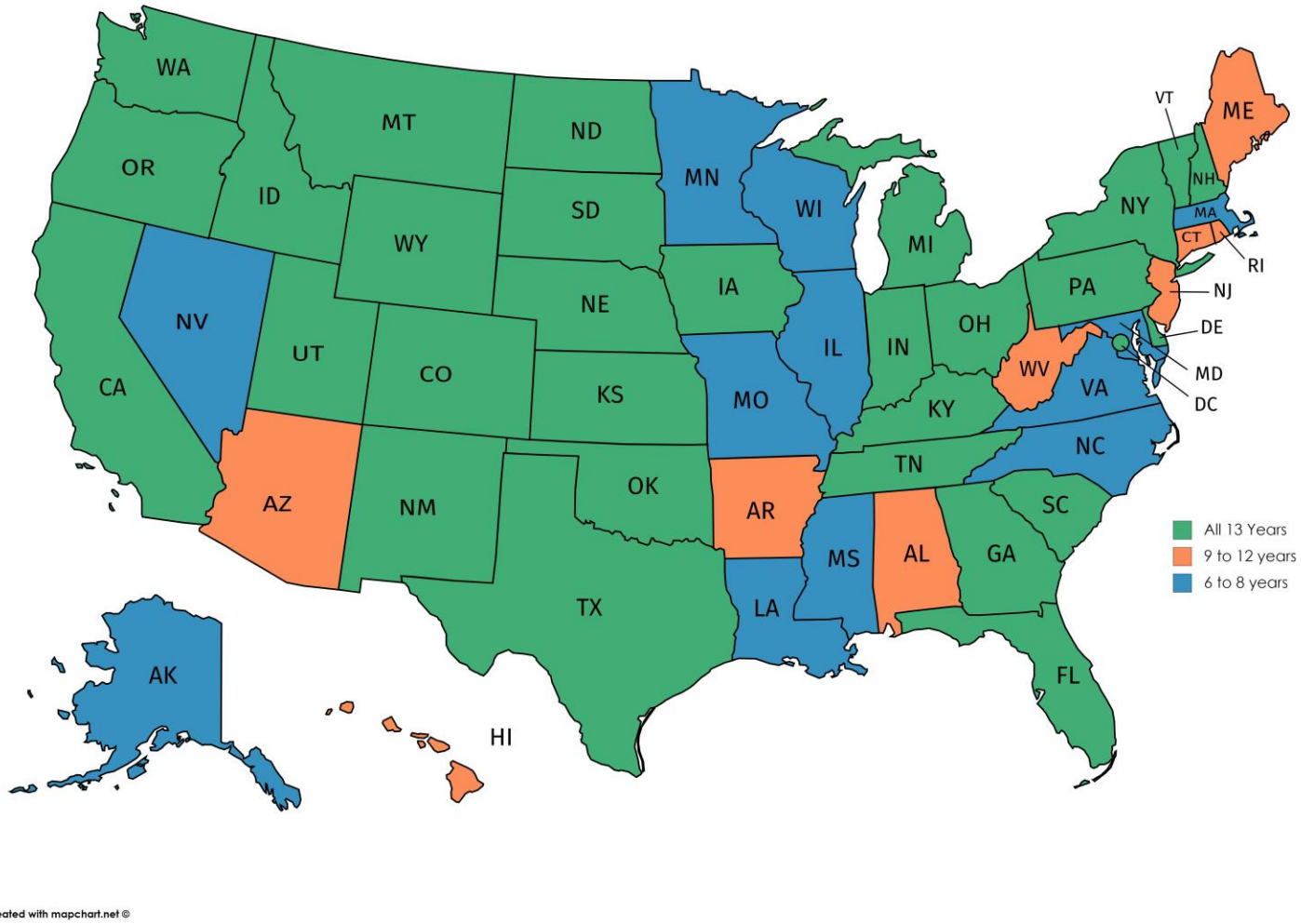
Appendix Table A4.1. Estimated quantile annual effects of state-level subminimum wage on infant birthweight standardized for gestational age, NVSS 2004-2016

Parameters	Percentile				
	5th	25th	50th	75th	95th
Subminimum Wage[1]	0.006 (0.005,0.007)	0.008 (0.008,0.009)	0.011 (0.010,0.011)	0.013 (0.012,0.013)	0.015 (0.014,0.017)
Year of Birth					
2004	Ref	Ref	Ref	Ref	Ref
2005	0.010 (0.006,0.013)	0.004 (0.002,0.007)	-0.002 (-0.004,0.000)	-0.004 (-0.007,-0.002)	-0.011 (-0.015,-0.006)
2006	0.010 (0.006,0.013)	0.002 (-0.001,0.004)	-0.005 (-0.007,-0.003)	-0.011 (-0.013,-0.008)	-0.026 (-0.030,-0.021)
2007	0.000 (-0.003,0.004)	-0.006 (-0.008,-0.004)	-0.015 (-0.017,-0.012)	-0.022 (-0.025,-0.020)	-0.035 (-0.039,-0.030)
2008	-0.009 (-0.012,-0.005)	-0.020 (-0.022,-0.017)	-0.030 (-0.032,-0.028)	-0.039 (-0.041,-0.036)	-0.047 (-0.051,-0.042)
2009	-0.009 (-0.014,-0.005)	-0.026 (-0.029,-0.024)	-0.042 (-0.044,-0.039)	-0.054 (-0.057,-0.051)	-0.064 (-0.069,-0.058)
2010	-0.010 (-0.014,-0.005)	-0.029 (-0.031,-0.026)	-0.044 (-0.047,-0.042)	-0.057 (-0.060,-0.054)	-0.066 (-0.071,-0.061)
2011	-0.018 (-0.023,-0.014)	-0.029 (-0.032,-0.026)	-0.041 (-0.044,-0.038)	-0.048 (-0.052,-0.045)	-0.051 (-0.057,-0.046)
2012	-0.004 (-0.009,0.001)	-0.018 (-0.021,-0.015)	-0.031 (-0.034,-0.028)	-0.040 (-0.043,-0.036)	-0.047 (-0.053,-0.041)
2013	-0.001 (-0.006,0.004)	-0.013 (-0.016,-0.010)	-0.023 (-0.026,-0.020)	-0.033 (-0.036,-0.029)	-0.041 (-0.047,-0.035)
2014	-0.014 (-0.019,-0.009)	-0.015 (-0.018,-0.012)	-0.021 (-0.024,-0.018)	-0.027 (-0.030,-0.023)	-0.029 (-0.035,-0.024)
2015	-0.015 (-0.020,-0.010)	-0.015 (-0.018,-0.012)	-0.022 (-0.025,-0.019)	-0.028 (-0.031,-0.025)	-0.026 (-0.031,-0.020)
2016	-0.020 (-0.025,-0.016)	-0.022 (-0.025,-0.019)	-0.028 (-0.031,-0.026)	-0.034 (-0.037,-0.031)	-0.029 (-0.034,-0.023)
Subminimum Wage*Year of Birth					
2004	Ref	Ref	Ref	Ref	Ref
2005	-0.001 (-0.002,0.000)	-0.001 (-0.002,0.000)	-0.001 (-0.002,0.000)	-0.002 (-0.003,-0.001)	-0.003 (-0.005,-0.001)
2006	0.002 (0.000,0.003)	0.002 (0.001,0.003)	0.002 (0.001,0.003)	0.002 (0.001,0.003)	0.000 (-0.002,0.002)
2007	0.005 (0.003,0.006)	0.002 (0.002,0.003)	0.001 (0.001,0.002)	0.001 (0.000,0.002)	-0.001 (-0.002,0.001)
2008	0.006 (0.004,0.007)	0.004 (0.003,0.005)	0.003 (0.002,0.003)	0.002 (0.001,0.003)	-0.001 (-0.002,0.001)
2009	0.000 (-0.001,0.002)	-0.001 (-0.002,0.000)	-0.002 (-0.003,-0.001)	-0.003 (-0.004,-0.002)	-0.004 (-0.006,-0.003)
2010	-0.001 (-0.002,0.001)	-0.002 (-0.002,-0.001)	-0.003 (-0.004,-0.002)	-0.003 (-0.004,-0.002)	-0.005 (-0.007,-0.003)
2011	0.002 (0.001,0.004)	-0.001 (-0.002,0.000)	-0.003 (-0.004,-0.002)	-0.004 (-0.005,-0.004)	-0.007 (-0.008,-0.005)
2012	0.002 (0.001,0.004)	-0.001 (-0.002,0.000)	-0.004 (-0.005,-0.003)	-0.005 (-0.006,-0.004)	-0.008 (-0.010,-0.007)
2013	0.003 (0.002,0.004)	-0.002 (-0.003,-0.001)	-0.006 (-0.007,-0.005)	-0.008 (-0.009,-0.007)	-0.011 (-0.013,-0.009)
2014	0.007 (0.006,0.008)	-0.001 (-0.002,0.000)	-0.005 (-0.006,-0.004)	-0.009 (-0.010,-0.008)	-0.013 (-0.015,-0.011)
2015	0.006 (0.005,0.007)	-0.003 (-0.004,-0.002)	-0.008 (-0.009,-0.007)	-0.012 (-0.013,-0.011)	-0.017 (-0.019,-0.015)
2016	0.005 (0.004,0.007)	-0.003 (-0.004,-0.002)	-0.008 (-0.009,-0.007)	-0.012 (-0.013,-0.011)	-0.016 (-0.018,-0.015)
Spring	0.009 (0.007,0.010)	0.009 (0.008,0.010)	0.009 (0.008,0.010)	0.009 (0.008,0.011)	0.007 (0.005,0.009)
Summer	0.004 (0.002,0.006)	-0.000 (-0.001,0.001)	-0.003 (-0.004,-0.002)	-0.007 (-0.009,-0.006)	-0.011 (-0.013,-0.009)
Fall	-0.004 (-0.006,-0.003)	-0.009 (-0.01,-0.008)	-0.011 (-0.012,-0.010)	-0.013 (-0.015,-0.012)	-0.015 (-0.017,-0.013)
Time-Variant State Characteristics					

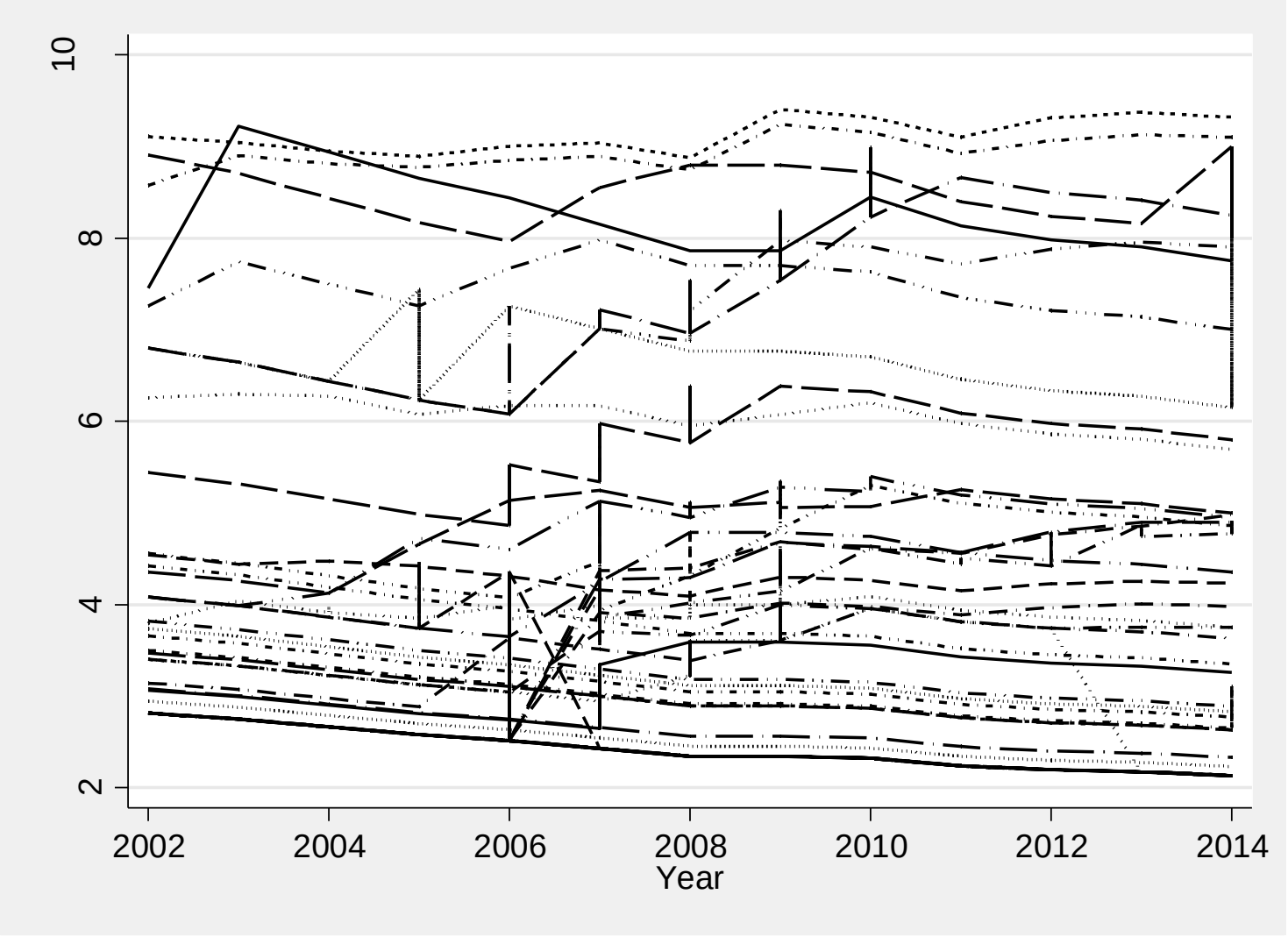
% Non-Hispanic White	-0.000 (-0.000,-0.000)	-0.001 (-0.001,0.000)	-0.000 (-0.001,0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)
% College Grad	-0.003 (-0.003,-0.003)	-0.005 (-0.005,-0.005)	-0.006 (-0.006,-0.006)	-0.007 (-0.007,-0.007)	-0.008 (-0.008,-0.007)
# employed in food service	0.000 (0.000,0.000)	0.000 (0.000,0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)
Mean Income	0.001 (0.001,0.002)	0.002 (0.001,0.002)	0.002 (0.002,0.002)	0.003 (0.002,0.003)	0.003 (0.003,0.003)
% Unemployed	-0.002 (-0.002,-0.001)	-0.000 (-0.001,0.000)	0.001 (0.001,0.002)	0.002 (0.002,0.003)	0.005 (0.004,0.006)
% Food Insecure	0.002 (0.001,0.002)	0.000 (0.000,0.001)	-0.000 (-0.001,-0.000)	-0.001 (-0.002,-0.001)	-0.002 (-0.003,-0.002)
Mean Welfare Benefit	0.008 (0.007,0.008)	0.007 (0.006,0.007)	0.005 (0.004,0.005)	0.003 (0.002,0.003)	0.005 (0.004,0.006)
% poverty	-0.006 (-0.007,-0.006)	-0.006 (-0.006,-0.006)	-0.006 (-0.006,-0.006)	-0.006 (-0.006,-0.005)	-0.005 (-0.006,-0.005)
% Democratic Representation	-0.035 (-0.038,-0.031)	-0.010 (-0.012,-0.008)	0.001 (-0.001,0.004)	0.013 (0.010,0.015)	0.033 (0.028,0.037)
Individual Characteristics					
Maternal age	0.025 (0.023,0.026)	0.031 (0.031,0.032)	0.034 (0.033,0.035)	0.036 (0.035,0.036)	0.039 (0.037,0.040)
Quadratic maternal age	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)	-0.000 (-0.000,-0.000)
Infant Sex: Female	0.015 (0.014,0.016)	-0.003 (-0.004,-0.002)	-0.007 (-0.008,-0.007)	-0.007 (-0.008,-0.006)	-0.002 (-0.003,0.000)
Non-HispanicBlack	-0.296 (-0.298,-0.293)	-0.310 (-0.311,-0.309)	-0.309 (-0.310,-0.307)	-0.289 (-0.290,-0.287)	-0.238 (-0.241,-0.236)
Non-HispanicAI/AN	0.018 (0.011,0.024)	0.047 (0.043,0.052)	0.076 (0.072,0.080)	0.113 (0.108,0.118)	0.191 (0.183,0.200)
Non-HispanicAsian/NHOPI	-0.294 (-0.297,-0.291)	-0.379 (-0.38,-0.377)	-0.408 (-0.409,-0.406)	-0.401 (-0.403,-0.399)	-0.351 (-0.355,-0.348)
Hispanic	-0.007 (-0.009,-0.005)	-0.040 (-0.041,-0.039)	-0.061 (-0.062,-0.059)	-0.071 (-0.072,-0.069)	-0.065 (-0.068,-0.063)
Married	0.118 (0.116,0.119)	0.101 (0.100,0.102)	0.092 (0.091,0.093)	0.082 (0.081,0.083)	0.065 (0.063,0.067)
Foreign-Born	0.075 (0.073,0.077)	0.038 (0.037,0.039)	0.019 (0.018,0.020)	0.003 (0.002,0.004)	-0.011 (-0.014,-0.009)
Multiparous	0.201 (0.199,0.202)	0.197 (0.196,0.198)	0.203 (0.202,0.204)	0.204 (0.203,0.205)	0.193 (0.192,0.195)
High School	0.096 (0.094,0.098)	0.068 (0.067,0.070)	0.056 (0.054,0.057)	0.041 (0.040,0.043)	0.024 (0.022,0.027)
Some College	0.196 (0.194,0.198)	0.148 (0.147,0.150)	0.126 (0.124,0.127)	0.098 (0.097,0.100)	0.063 (0.061,0.066)
≥ College	0.278 (0.276,0.280)	0.201 (0.199,0.202)	0.161 (0.160,0.163)	0.114 (0.112,0.115)	0.039 (0.036,0.042)
Intercept	-2.193 (-2.215,-2.170)	-1.279 (-1.293,-1.265)	-0.64 (-0.654,-0.626)	0.032 (0.016,0.048)	0.954 (0.927,0.981)

Appendix 4 Figures

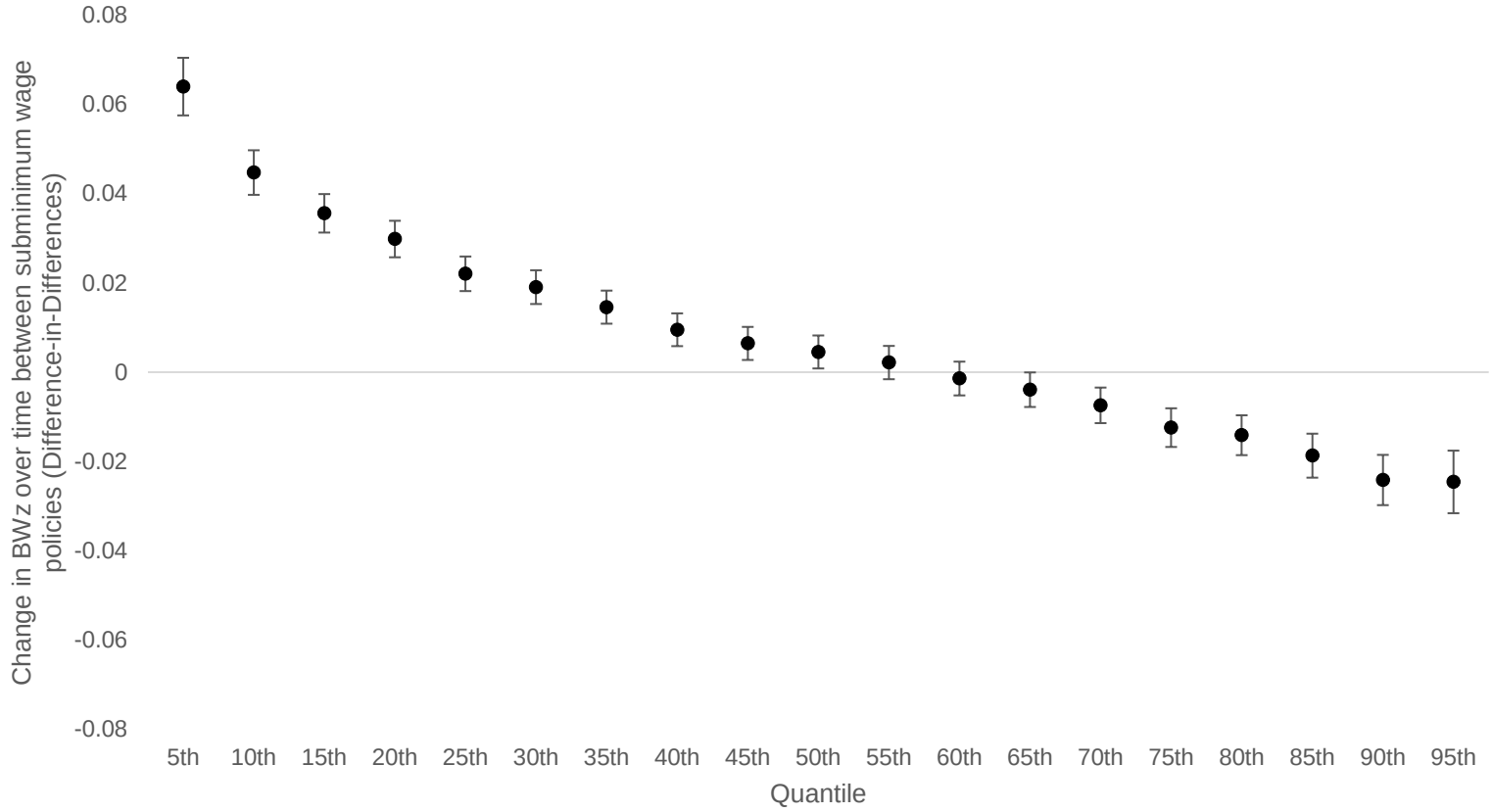
Appendix Figure A4.1. Availability of maternal education data by state, 2004-2016 Vital Statistics Natality Files



Appendix Figure A4.2 Tipped worker subminimum wage (2014 US dollars) over time by state



Appendix Figure A4.3. Change in birthweight standardized for gestational age over time (2004-2016) when wage policy is set to 100% federal minimum wage ($5.15 to $7.25) relative to the federal tipped worker subminimum wage (constant $2.13) as estimated in linear quantile mixed effects models[a], 2004-2016 Vital Statistics Natality Files (restricted to states with consistent maternal education data availability)



BWz, Birthweight for gestational age z-score

[a]Estimates are presented for each quartile with 95% confidence interval. All models adjust for season, state-level variables lagged three years from infant year and month of birth (% Democrats in state government, maximum monthly benefits from state income supports, % White alone, % with college degree, number in food service occupation, % unemployed, % food insecure, and mean personal income) as well as maternal race/ethnicity, education, age, quadratic age, parity, nativity, marital status and infant sex