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State minimum wage laws and newly diagnosed cases of HIV among heterosexual black residents of US metropolitan areas☆

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A B S T R A C T

This ecologic cohort study explores the relationship between state minimum wage laws and rates of HIV diagnoses among heterosexual black residents of U.S metropolitan areas over an 8-year span. Specifically, we applied hierarchical linear modeling to investigate whether state-level variations in minimum wage laws, adjusted for cost-of-living and inflation, were associated with rates of new HIV diagnoses among heterosexual black residents of metropolitan statistical areas (MSAs; n = 73), between 2008 and 2015. Findings suggest that an inverse relationship exists between baseline state minimum wages and initial rates of newly diagnosed HIV cases among heterosexual black individuals, after adjusting for potential confounders. MSAs with a minimum wage that was $1 higher at baseline had a 27.12% lower rate of newly diagnosed HIV cases. Exploratory analyses suggest that income inequality may mediate this relationship. If subsequent research establishes a causal relationship between minimum wage and this outcome, efforts to increase minimum wages should be incorporated into HIV prevention strategies for this vulnerable population.

1. Introduction

In the United States, HIV has taken a grave toll on black adults and adolescents (CDC, 2016; HIV among African Americans, 2017; Aral, Adimora, & Fenton, 2008). Though just 12% of US residents are black, black men and women have experienced nearly half of all HIV-related deaths since the epidemic's onset, and currently represent about 40 percent of people living with HIV (CDC, 2016; HIV among African Americans, 2017). Heterosexual black men and women bear a significant burden: 34 percent of infections diagnosed in 2015 among black residents were attributed to heterosexual contact (CDC, 2016; HIV among African Americans, 2017; Adimora & Schoenbach, 2002). The CDC projects that if these trends persist, about one in 20 black men and one in 48 black women will contract HIV in their lifetimes (HIV among African Americans, 2017).

Researchers using a social-ecologic framework to investigate determinants of HIV-related outcomes have shown that individual behaviors cannot fully account for greater vulnerabilities to HIV experienced by heterosexual black adults and adolescents. Rather, the social, economic, and political contexts in which people are born, live, and work shape the disparate distribution of HIV across racial/ethnic groups (Adimora & Schoenbach, 2002; Adimora & Schoenbach, 2005; Buot et al., 2014).

Poverty – operating at the levels of individuals and communities – is a well-established, strong determinant of HIV infections among black adults and adolescents (Aral et al., 2008; Buot et al., 2014; Harling et al., 2014). This key social exposure, however, is itself largely created, controlled, and alleviated through systems of laws and economic forces. Yet, public health research has rarely examined specific laws that govern distributions of poverty in society as determinants of HIV or other outcomes. The current analysis builds on an emerging body of research (Averett, Smith, & Wang, 2016; Bullinger, 2017; Komro,

Livingston, Markowitz, & Wagenaar, 2016; Kronenberg, Jacobs, & Zucchelli, 2017; Lenhart, 2017; Tsao et al., 2016; Van Dyke et al., 2018) to address this weakness by exploring the extent to which minimum wage laws relate to newly diagnosed cases of HIV among black adults. We situate this research in its historical context to illuminate its specific relevance to the health and well-being of black people.

1.1. A brief history of minimum wage laws, public health, and race

In the early 1900s, in the wake of rapid urbanization, immigration, and industrialization, states began enacting minimum wage laws in response to mounting concerns for the health and safety of the growing number of women and children joining the labor force in factories, agriculture, and service industries (Kelley, 1912; Mills, 1914; Persons, 1915). Protecting public health was a prominent concern among some advocating for minimum wage legislation. For example, California's first statute stated that minimum wage should be "not less than a wage adequate to supply to such women and minors the necessary cost of proper living and to maintain their health and welfare" (Persons, 1915).

In 1912, Florence Kelley, a leader of the National Consumers League, viewed establishing minimum wage laws as a public health imperative that would reduce psychological stress and substance use among workers and families, allow youth to complete more years of education, and help control the spread of tuberculosis in the population (Kelley, 1912):

> The advocates of minimum-wage boards are animated by the hope that the boards may produce far-reaching indirect effects. Thus child labor can be more effectively minimized and school life prolonged, when unskilled fathers attain a living wage for the maintenance of their families, and when minors must be paid a reasonable wage and can no longer be had for a song. Tuberculosis can be warded off when wage-workers can more universally afford a nutritious dietary, and the tuberculosis crusade may thus become a less hopeless undertaking. Those cases of insanity which arise from worry over insufficient wages combined with physical depletion due to a too low standard of living may reasonably be expected to diminish when wages are rationalized. And the same reasoning applies in great measure to alcoholism. (pg. 1010).

The Fair Labor Standards Act (FLSA), passed in the shadows of the Great Depression, created the federal minimum wage in 1938. While a victory for Progressive Era policymakers, the FLSA was fraught with racial discrimination (McGuire, 2012). Wealthy Southern capitalists whose businesses depended on agricultural labor of mostly black men and whose households relied on domestic services of mostly black women, staunchly opposed a federal minimum wage (Mutari, Power, & Figart, 2002). In 1938, before the FLSA was enacted, the U.S. Women's Bureau estimated that a quarter of all black women resided in states with minimum wage laws, but only one in 10 would be protected under the law (Mutari et al., 2002). As a political compromise to secure congressional votes, the final version excluded agricultural and domestic workers from its minimum wage mandate (McGuire, 2012).

From the end of WWII through the 1960s, the federal minimum wage increased in step with labor productivity. Its inflation-adjusted value peaked in 1968, valued at $9.24 in 2014 dollars (Cooper, 2015). Overall, however, the federal minimum wage has not kept pace with increases in labor productivity or economic profits since the New Deal era. Despite inflation and changes in the cost of living, Congress has only adjusted the federal minimum wage nine times in the 80 years since it was passed, from 25 cents per hour in 1938 to the current $7.25, where it has remained stagnant since 2009 (Cooper, 2015; Huizar & Gebreselassie, 2016; Martin, 2014).

As of 2018, however, 29 states and dozens of cities and counties have passed laws establishing hourly wages greater than the federal requirement of $7.25 (Cooper, 2015). While the impacts of minimum wages are hotly debated, many economists contend that a stagnant minimum wage is one reason that American families are falling further behind economically, income inequalities are widening, and living conditions are worsening in many parts of the US (Huizar & Gebreselassie, 2016; Martin, 2014; Saez & Zucman, 2016; David, Manning, & Smith, 2016).

Increasing federal minimum wages is a core component of policy platforms of political figures, organized labor, and advocacy groups committed to economic and racial justice. The Leadership Conference for Civil and Human Rights, The National Urban League, and legal scholars view raising minimum wages as a civil rights imperative for healing the wounds of economic injustices inflicted on black communities (Civil and Human, 2017). Indeed, black adults, especially women and those living in Southern states, are overrepresented in jobs covered by minimum wage laws, including in food service, retail, home care, child care, and hospitality industries (Huizar & Gebreselassie, 2016; Martin, 2014; Saez & Zucman, 2016; Parks, 2012). Nationally, about 38% of all black workers have jobs that pay under $12 an hour. Economists project that black women who are mothers and heads of household would benefit more than any other demographic from raising the federal minimum wage (Huizar & Gebreselassie, 2016; Parks, 2012). Yet, structural racism still lurks in contemporary politics of minimum wage laws. For example, the NAACP is currently litigating the constitutionality of Alabama's preemption law on grounds of 'racial animus' after the state's majority-white legislature hastily passed a bill setting a uniform statewide minimum wage at $7.25 to undo Birmingham's majority-black city council's ordinance setting a living wage of $10.10 for its residents (Alabama State Conference of the NAACP v).

Given that the origins of minimum wage laws lie, in part, in public health concerns and that racism has shaped these laws' coverage and existence, it is surprising that virtually no scholarship has studied the roles of minimum wage laws in shaping the health of black people.

1.2. Prior studies on minimum wage and health

The nascent, yet growing body of literature examining associations between minimum wage increases and health has reached mixed conclusions, with most studies showing improvements (Komro et al., 2016; Lenhart, 2017; Tsao et al., 2016; Van Dyke et al., 2018); a handful suggesting adverse impacts (Adams, Blackburn, & Cotti, 2012); and others showing either insignificant (Kronenberg et al., 2017) or mixed effects (Averett et al., 2016) on various health indicators among different study populations. Komro et al. (2016), for example, used a quasi-experimental design to test effects of states' minimum wage changes, from 1980 to 2011, on infant mortality and birth weight. Their findings suggest that increasing state minimum wages by 1 dollar above the federal threshold likely accounted for 1% to 2% reductions in rates of low birth weight, and a 4% drop in post-neonatal mortality at the state level (Komro et al., 2016). Tsao et al. (2016) estimate that raising the minimum wage in New York City to $15 hourly would save about 2800 lives in five years, and would mostly benefit neighborhoods where the majority of residents are black and living below the federal poverty level (Tsao et al., 2016). By contrast, Horn, MacLean, and Strain found that increased minimum wages were associated with *worse* overall self-reported health status among men and women, but with improved mental health status among working women over a 23-year span (Horn, Maclean, & Strain, 2017). No study to our knowledge has examined the relationship between minimum wages and HIV outcomes.

1.3. Current study

The present analysis is guided by Buot et al.'s theoretical framework describing how macro-level socioeconomic determinants shape HIV vulnerabilities among Black men and women (Buot et al., 2014). Their model posits that these distal forces cultivate social, economic, and political conditions that disparately impact black communities and that propagate vulnerability to HIV. Specifically, they posit that in contexts

of high unemployment rates, social disorganization, low marriage rates, imbalanced sex ratios, mass incarceration, poor healthcare access, and migration, people are more likely to engage in behaviors that increase risk for acquiring or transmitting HIV, such as transactional sex, illicit substance misuse, condomless sex, and concurrent sexual partners (Adimora & Schoenbach, 2002; Adimora & Schoenbach, 2005; Buot et al., 2014; Adimora & Schoenbach, 2013). Guided by this framework, the present study analyzes whether state minimum wage laws are inversely related to rates of newly diagnosed HIV cases among black heterosexuals living in large metropolitan statistical areas (MSA) over an eight-year span (2008–2015).

Buot et al.'s framework and past research also guided an exploratory mediation analysis designed to investigate possible pathways linking minimum wage to HIV. While economic literature has reached mixed conclusions about the effects of minimum wages, some studies indicate that increasing minimum wages mitigates levels of unemployment, poverty, incarceration, public assistance, and income inequality (Neumark & Wascher, 2011; Belman, Wolfson, & Nawakitphaitoon, 2016). Studies examining the economic impacts of minimum wage laws on non-Hispanic black groups are surprisingly lacking in the literature (Belman et al., 2016). Because each of these exposures has, in turn, been associated with vulnerability to HIV among non-Hispanic black people (Adimora & Schoenbach, 2002; Adimora & Schoenbach, 2005; Buot et al., 2014; Adimora & Schoenbach, 2013), we preliminarily explored them as mediators of the minimum wage/outcome relationship to support future research on mechanisms.

2. Material and methods

The unit of analysis is the MSA, defined as a "core area containing a population nucleus (> 500,000 residents), together with adjacent communities with a high degree of economic and social integration with that core." To be included in this analysis, an MSA had to have a population size > 500,000 in 1993 (N = 96), the beginning of the study period for the larger study in which this analysis is embedded. Cost of living data were unavailable for 23 MSAs, reducing our final sample size to 73 MSAs. Because this larger study spans 1992–2015, we used 1993 MSA boundaries.

2.1. Measures

Supplemental Table 1 details the data type and source for each measure described below.

2.1.1. Outcome

The outcome was the annual rate of newly diagnosed cases of HIV among black heterosexuals in each MSA, as expressed in the formula below:

$$\frac{\text{No. of black heterosexual contact HIV diagnoses}_{\text{YeariMSAj}}}{\text{No. residents aged 15} - 64 \text{years who are black}_{\text{YeariMSAj}}} \times 10,000 \quad (1)$$

Numerator data were derived data from the Center for Disease Control and Prevention's (CDC's) HIV name-based reporting system, which began in 2008. Name-based reporting is a more accurate measure of new diagnoses than prior surveillance modes, which could not distinguish instances in which two people were newly diagnosed from instances in which the same person was tested twice. Population data for non-Hispanic black adults and adolescents were obtained from the US Census Bureau's Intercensal Population Estimates.

2.1.2. Independent variable

Our focal independent variable, the annual minimum wage, was coded by Komro et al. Two legal researchers conducted blinded independent coding of legislation to identify monthly state minimum wage values, with a first-pass score of 86% and disagreements resolved

by a senior attorney (Komro et al., 2016). The monthly minimum wage was averaged across time to calculate a yearly value, and was adjusted for inflation using the consumer price index and for local cost of living, using approximations from a Council for Community and Economic Research index. The cost of living index is created using weighted categories of household expenditures collected at the local level. The average for the cost of living index for all participating places equals 100, and each participant's index is read as a percentage of the average for all places. MSAs that crossed state boundaries were assigned to states based on population size.

2.1.3. Possible confounders

Possible confounders were: government health expenditures (Chen et al., 2014), health insurance rates (Levy & Meltzer, 2008), percent of non-Hispanic black adults without a high school diploma (Belman et al., 2016; Sabia, 2008), percent of non-Hispanic black persons living in an area with a shortage of healthcare providers, and "syringe coverage" by local syringe service programs (Bramson et al., 2015; Williams & Metzger, 2010). Recognizing that interventions targeting one key population may affect others (Friedman et al., 2014) we included an estimate of "syringe coverage" in 2007, defined as number of syringes exchanged by syringe exchange programs in each MSA, divided by Tempalski et al.'s estimate of the number of people who inject drugs (PWID) in that MSA (Tempalski et al., 2013).

2.1.4. Possible mediators

We conducted exploratory mediation analysis to assess if any of six possible mediators might lie between the causal pathway of minimum wage and new HIV diagnoses. These included: yearly percent of non-Hispanic black adults who were employed (Adimora & Schoenbach, 2002; Adimora & Schoenbach, 2005), the percent of non-Hispanic black people subsisting below the federal poverty level (Aral et al., 2008; Adimora & Schoenbach, 2002; Adimora & Schoenbach, 2005); the percent of the adult population in correctional facilities (data were not available by race/ethnicity) (Johnson & Raphael, 2009; Western, Kleykamp, & Rosenfeld, 2002; Khan et al., 2009); the Gini Index, a measure of income inequality (Buot et al., 2014; Harling et al., 2014; Holtgrave & Crosby, 2003; Smeeding, 2005); the percent of black households participating in the supplemental nutrition assistant program (Anema, Vogenthaler, Frongillo, Kadiyala, & Weiser, 2009); and the percent of households receiving public income assistance income including Temporary Assistance to Needy Families (data were not available by race/ethnicity) (Raissian & Bullinger, 2017; Dube, 2017).

2.2. Analysis

We used descriptive statistics to summarize central tendencies and dispersions of all variables. We used a 2-level hierarchical linear modeling (HLM) (Singer JD, 2003) approach to growth modeling to assess the longitudinal relationship between variations in state minimum wage laws and rates of new HIV diagnoses among heterosexual black adults over time (2008–2015) (Cooper et al., 2008). Specifically, we modeled the relationship between minimum wage at baseline and yearly HIV diagnoses (2008–2015) to assess the average difference in the intercept, or initial status, for HIV diagnoses for MSAs that were one dollar higher in baseline minimum wage after adjusting for potential confounders. We also modeled the relationship between yearly change in minimum wage since baseline and HIV diagnoses to assess the average rate of change in HIV diagnoses for MSAs with a one dollar increase in minimum wage since baseline while controlling for potential confounders. Our HLM accounted for the clustering of yearly measures within MSAs by using a random effect for MSAs (Singer JD, 2003). We used a fixed effect for state to account for attributes of states that may impact our outcome and are not measured with our data (Gunasekara, Richardson, Carter, & Blakely, 2013). Fixed effects do not use between-MSA information, and therefore are not influenced by

confounding due to unmeasured time-invariant factors. HIV diagnosis rates among black heterosexual adults were natural log transformed to linearize the variable's association with covariates. Modeling unfolded in four stages:

2.2.1. Stage 1: Modeling change in the outcome over time

We used HLM to model growth curves for HIV diagnoses, coding time as the number of years since 2007 to facilitate interpretation of coefficients. To learn if HLM was warranted, we assessed the covariance parameters, and calculated intraclass correlation coefficients (ICCs) and reduction in the residual outcome variance between unconditional means and growth models (pseudo R2) to assess the variability of the outcome within and between MSAs and its association with time (Singer JD, 2003). We tested linear, quadratic, and cubic time models; the quadratic time function produced the smallest Akaike information criteria (AIC), indicating that this operationalization of time was the optimal model of change in the outcome across the study period.

2.2.2. Stage 2: Bivariate multilevel models

To aid interpretation, we centered time-varying covariates at baseline, creating two variables (baseline and change since baseline). We tested 1-, 2-, and 3-year lags in covariates because we did not expect a change in the minimum wage to have an instantaneous effect on the outcome. The 1-year lag yielded the largest correlation between the minimum wage and HIV diagnoses.

We used the 1-year lag variable "dyads" (e.g., baseline [2007] health expenditures and change in health expenditures) in bivariate HLMs to determine which covariates might be possible confounders and should be included in the final model. Each "bivariate" model included the quadratic operationalization of time, baseline covariate (lagged by 1 year), and change in the covariate since baseline. Since our initial sample was a census of MSAs with a population of 500,000 or greater, we relied on the magnitudes of association instead of *p* values to determine substantive significance. To evaluate the magnitude of association with our outcome for centered variable dyads, we summed the absolute values of each dyad's 2 standardized betas. We included dyads in the final model when this sum was $\geq |0.20|$ or when variables were of theoretical interest (Cooper et al., 2008).

2.2.3. Stage 3: Multivariable multilevel analysis

The final HLM included all covariates that met the bivariate model cut point for inclusion; the percent of uninsured residents did not meet this cutpoint but was of the theoretical interest, and so it was included in the multivariable model (David et al., 2016). When interpreting final model results, *a priori* we set substantive significance to be a standardized beta $\geq |0.10|$ (Cooper et al., 2008).

2.2.4. Stage 4: Exploratory mediation analysis

To explore possible mediators of the minimum wage to HIV relationship, we re-ran the final model, once for each possible mediator. We used a change of $\geq |10\%|$ in the magnitude of the minimum wage effect estimate between the unmediated and mediated models to identify possible mediators (Williams & Metzger, 2010).

3. Results

3.1. Descriptive statistics

In 2007, the MSA median minimum wage, adjusted for cost of living and inflation, was $7.01 (25th and 75th percentiles: $6.34, $7.69); minimum wage increased minimally from 2007 to 2014 (Median: $0.19, 25th and 75th percentiles: $-0.04, $1.02) (Table 1). Our primary exposure was inflation and cost of living adjusted minimum wage; for descriptive purposes we provide information on the number of MSAs with an inflation and cost of living adjusted minimum wage below vs. above the real, inflation adjusted federal minimum wage. In 2007, 16

MSAs had an adjusted minimum wage below the real federal level of $6.24, and 57 MSAs had a minimum wage above the federal minimum. In 2014, 28 MSAs had an adjusted minimum wage below the real federal level of $7.29, and 45 MSAs had a minimum wage above the federal minimum. The median percentages of residents without health insurance in 2007 was 16% (25th and 75th percentiles: 12.01%, 19.50%). The median baseline Gini index, our income inequality measure, was 0.45 (25th and 75th percentiles: 0.44, 0.46). From 2007 to 2014 the median Gini index increased by 0.02 (25th and 75th percentiles: 0.01, 0.02).

The median rate of newly diagnosed cases of HIV among black heterosexuals was 2.46 per 10,000 adults in 2008 (25th and 75th percentiles: 1.75/10,000, 4.00/10,000). The median change in diagnoses over time was -1.06/10,000 (25th and 75 percentiles: -1.91/10,000, -0.37/10,000).

3.2. Growth model

Analysis of the ICC suggested that a meaningful proportion of the outcome variance was attributable to differences between MSAs (28%), thus justifying multilevel growth modeling. Comparison of unconditional means and growth models in HLM indicated that 24% of the outcome variation within MSA was associated with quadratic time (pseudo $R^2 = 0.24$). The decrease in percent change in number of years since 2007 (-10.30%) and increase in percent change in the quadratic term, years since 2007 squared, (0.78%) describes a trajectory where HIV steadily decreases for a period of time then slightly increases in later years.

3.3. Bivariate multilevel analysis

Bivariate HLM results showed that minimum wage, health expenditures per capita (Chen et al., 2014), non-Hispanic black persons without a high school diploma (Buot et al., 2014; Belman et al., 2016), and baseline syringes exchanged per PWID (Bramson et al., 2015; Williams & Metzger, 2010) met the statistical cutpoint for inclusion (i.e., variable dyad absolute sum of $> |0.20|$ for time-varying measures or $> |0.10|$ for non-time varying measures) in the final model (Table 2).

3.4. Multivariable multilevel analysis

We found an inverse, substantively significant association between baseline minimum wage and initial rates of HIV diagnoses among Black heterosexuals. MSAs in states with a minimum wage that was one standard deviation higher at baseline had (logged) rates of newly diagnoses cases of HIV among Black heterosexuals that were 0.42 (CI: -0.58, -0.25) lower. A one standard deviation increase in minimum wage over time was associated with a 0.06 (CI: -0.15, 0.03) reduction in the log outcome (Table 2), but this increase did not meet our cutpoint for substantive significance. We had log transformed the outcome for model-building purposes. To aid interpretation, we used a back transformation to calculate percent change in new HIV diagnoses per 10,000 for a one-dollar change in minimum wage. These calculations indicate that the rate of newly diagnosed cases of HIV among black heterosexual adults was 27.12% lower in MSAs with a $1 higher minimum wage at baseline (Table 3).

3.5. Exploratory mediation analyses

Our exploratory mediation analysis suggested that the Gini index variable, a measure of income inequality, might mediate the focal relationship (Table 4). Adding this covariate to the final model decreased the relationship between baseline minimum wage and new HIV diagnoses by 29%, exceeding our 10% cut point for identifying putative mediators.

Table 1

Rates and Potential Covariates of Newly Diagnosed Cases of Heterosexually Acquired HIV (per 10,000) Among Black Adults (Aged 15–64 Years), residing in 73 Large US Metropolitan Statistical Areas, 2008–2015[a].

MSA Level Characteristics	Mean	Standard Deviation	Median	25th Percentile	75th Percentile
Newly diagnosed cases of HIV per 10,000 black heterosexual adults					
Baseline (2008)	3.26	2.43	2.46	1.75	4.00
Change between 2008 and 2015	-1.23	1.63	-1.06	-1.91	-0.37
Average state minimum wage (cost of living and inflation adjusted), $					
Lagged baseline (2007)	6.94	0.92	7.01	6.34	7.69
Change between 2007 and 2014	0.36	0.53	0.19	-0.04	1.02
Health expenditures per capita, $					
Lagged baseline (2007)	143.82	212.40	80.46	48.40	178.82
Change between 2007 and 2014	-24.64	281.63	1.31	-12.23	18.08
Residents uninsured, %					
Lagged baseline (2007)	16.76	5.28	16.19	12.01	19.50
Change between 2007 and 2014	-3.75	2.15	-3.42	-5.11	-1.96
Non-Hispanic black adults without a high school diploma, %					
Lagged baseline (2007)	16.61	4.67	16.82	13.81	19.55
Change between 2007 and 2014	-3.47	1.69	-3.72	-4.64	-2.53
Non-Hispanic black people living in a Health Provider Shortage Area, %					
Lagged baseline (2007)	17.72	19.63	12.97	0.58	23.24
Syrinage coverage					
Lagged baseline (2007)	12.33	28.60	0.00	0.00	9.27
Possible Mediators					
Non-Hispanic black residents below poverty level, %					
Lagged baseline (2007)	19.94	6.49	19.25	15.76	23.81
Change between 2007 and 2014	0.78	2.80	0.92	-0.60	1.87
Employed non-Hispanic black adults, %					
Lagged baseline (2007)	61.20	5.96	62.82	57.96	65.26
Change between 2007 and 2014	-0.07	2.31	0.01	-1.59	1.40
Gini index					
Lagged baseline (2007)	0.45	0.02	0.45	0.44	0.46
Change between 2007 and 2014	0.01	0.01	0.02	0.01	0.02
Incarcerated, %[b]					
Lagged baseline (2007)	0.87	0.75	0.72	0.56	0.96
Change between 2007 and 2014	-0.03	0.12	-0.02	-0.06	0.03
Households receiving public assistance income, %[b]					
Lagged baseline (2007)	2.34	0.95	2.14	1.70	2.82
Change between 2007 and 2014	0.32	0.56	0.24	0.04	0.64
Black households participating in SNAP, %					
Lagged baseline (2007)	18.32	7.36	18.07	13.13	23.57
Change between 2007 and 2014	7.87	3.77	7.22	5.15	10.47

[a] 2008 to 2015 refers to the timeframe for the HIV diagnoses outcome. Covariates were lagged 1 year and reflect 2007–2011. Note: Covariates were lagged one year because we did not expect a change in the covariates to have an instantaneous effect on the outcome.

[b] Incarceration and public assistance income data were not available by race/ethnic from the American Community Survey 5-year estimates.

4. Discussion

For decades, nearly all studies of minimum wage laws' effects have focused on economic outcomes. While public health issues have been a part of minimum wage debates since their inception, and though addressing economic inequalities is of central importance to the field, researchers are only beginning to quantify minimum wage laws' impacts on population health. So far, most studies indicate that higher minimum wages benefit population health (Bullinger, 2017; Kronenberg et al., 2017; Lenhart, 2017; Tsao et al., 2016; Van Dyke et al., 2018; Horn et al., 2017; Komro et al., 2016; McCarrier, Zimmerman, Ralston, & Martin, 2011; Reeves et al., 2017; Wehby, Dave, & Kaestner, 2016).

This study is a novel contribution to this growing body of work. We found a substantively significant, inverse relationship between baseline state minimum wage and initial rates of newly diagnosed HIV cases among black heterosexuals, after adjusting for cost-of-living and controlling for confounders. Specifically, MSAs with a minimum wage that was $1 higher at baseline had a 27.12% lower rate of newly diagnosed HIV cases.

We preliminarily explored possible mediators to support future analyses of causal pathways linking minimum wage and HIV. We found that income inequality might mediate the relationship between minimum wage and rates of HIV diagnosis, but poverty rates among black households, unemployment rates among black adults, percent of residents on SNAP, percent of residents on SNAP, and incarceration rates did not appear to do so. Economists have shown that minimum wage laws reduce inequality for people at the lower tail of the income distribution, especially women (David et al., 2016). While research has not pinpointed mechanisms linking income inequality to HIV, it portends plausible pathways. Buot et al. found that income inequality was among the strongest predictors of HIV incidence and prevalence in U.S. cities, especially for HIV diagnoses transmitted via heterosexual exposure (Buot et al., 2014). Prior studies show that higher income inequality may lead to decreased social cohesion, increased crime rates, and lower marriage rates, each of which is associated with HIV (Buot et al., 2014; Adimora & Schoenbach, 2013; Adimora et al., 2014; Adimora, Schoenbach, & Doherty, 2006). Adimora and Wingood posit that providing greater economic security may improve gendered power dynamics (Sabia, 2008), and foster higher rates of marriages and

Table 2

Multilevel[a] Bivariate and Multivariable Results of Regressing Log Rates of Newly Diagnosed Cases of Heterosexually Acquired HIV (per 10,000) Among Black Adults (Aged 15–64 Years) on State Minimum Wage and Potential Covariates in 73 Large US Metropolitan Statistical Areas, 2008–2015[b].

Covariate	Bivariates Standardized B (95% CI[c])	Final Model Standardized B (95% CI)
Average state minimum wage (cost of living and inflation adjusted), $		
Lagged baseline (2007)	-0.25 (-0.42, -0.08)	-0.42 (-0.58, -0.25)
Yearly change since 2007	-0.06 (-0.15, 0.03)	-0.06 (-0.15, 0.03)
Health expenditures per capita, $		
Lagged baseline (2007)	0.16 (0.03, 0.28)	-0.03 (-0.15, 0.09)
Yearly change since 2007	0.05 (-0.03, 0.14)	0.04 (-0.05, 0.12)
Residents uninsured, %		
Lagged baseline (2007)	0.12 (-0.17, 0.42)	0.17 (-0.09, 0.43)
Yearly change since 2007	0.05 (-0.03, 0.13)	0.01 (-0.07, 0.09)
Non-Hispanic black adults without a high school diploma, %		
Lagged baseline (2007)	0.27 (0.11, 0.43)	0.45 (0.28, 0.61)
Yearly change since 2007	-0.05 (-0.16, 0.06)	-0.02 (-0.13, 0.09)
Non-Hispanic black people living in a Health Provider Shortage Area, %		
Lagged baseline (2007)	0.02 (-0.13, 0.17)	Eliminated
Syringe coverage		
Lagged baseline (2007)	0.13 (-0.02, 0.28)	0.05 (-0.08, 0.18)
Possible Mediators[d]		
Non-Hispanic black residents below poverty level, %		
Lagged baseline (2007)	0.03 (-0.15, 0.21)	–
Yearly change since 2007	0.09 (0.01, 0.16)	–
Employed non-Hispanic black adults, %		
Lagged baseline (2007)	0.06 (-0.08, 0.20)	–
Yearly change since 2007	0.06 (-0.03, 0.15)	–
Gini index		
Lagged baseline (2007)	0.39 (0.26, 0.52)	–
Yearly change since 2007	0.06 (-0.06, 0.17)	–
Incarcerated, %		
Lagged baseline (2007)	-0.06 (-0.16, 0.04)	–
Yearly change since 2007	-0.02 (-0.12, 0.08)	–
Households receiving public assistance income, %		
Lagged baseline (2007)	-0.09 (-0.24, 0.05)	–
Yearly change since 2007	-0.07 (-0.15, 0.01)	–
Black households participating in SNAP, %		
Lagged baseline (2007)	0.07 (-0.17, 0.31)	–
Yearly change since 2007	-0.03(-0.16, 0.10)	–

Note: The outcome was natural log transformed to linearize its association to the covariates.

[a] Two level multilevel model with yearly observations (2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2105) nested within MSA. Model includes state as a fixed effect and time function that yielded the smallest AIC (fixed effect quadratic and random linear time).

[b] 2008 to 2015 refers to the timeframe for the HIV diagnoses outcome. Covariates were lagged 1 year and reflect 2007–2014. Note: Covariates were lagged one year because we did not expect a change in the covariates to have an instantaneous effect on the outcome.

[c] CI = Confidence interval. We determined substantive significance using an absolute value cut point, and not a CI, as described in the methods. Confidence intervals are provided as a heuristic.

[d] Combined models with possible mediators shown in Table 4.

Table 3

Multilevel[a] Multivariable Regression Percent Change in Model-Based Rates of Newly Diagnosed Cases of Heterosexually Acquired HIV (per 10,000) Among Black Adults (Aged 15–64 Years) in 73 Large US Metropolitan Statistical Areas, 2008–2015[b].

Covariate	Final Model % Change[c] in the outcome (95% CI[d])
Time	
No. of years since 2007	-10.30 (-15.19, -5.12)
No. of years since 2007, squared	0.78 (0.02, 1.55)
Average state minimum wage (cost of living and inflation adjusted), $	
Lagged baseline (2007)	-27.12 (-35.18, -18.06)
Yearly change since 2007	-5.98 (-14.34, 3.21)
Health expenditures per capita, $	
Lagged baseline (2007)	-0.01 (-0.05, 0.03)
Yearly change since 2007	0.02 (-0.02, 0.05)
Residents uninsured, %	
Lagged baseline (2007)	2.31 (-1.01, 5.75)
Yearly change since 2007	0.42 (-1.88, 2.77)
Non-Hispanic black adults without a high school diploma, %	
Lagged baseline (2007)	6.39 (3.99, 8.84)
Yearly change since 2007	-0.34 (-4.60, 4.11)
Syringe coverage	
Lagged baseline (2007)	0.18 (-0.15, 0.52)

[a] Two level multilevel model with yearly observations (2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2105) nested within MSA. Model includes state as fixed effect and time function that yielded the smallest AIC (fixed effect quadratic and random linear time).

[b] 2008 to 2015 refers to the timeframe for the HIV diagnoses outcome. Covariates were lagged 1 year and reflect 2007–2014. Note: Covariates were lagged one year because we did not expect a change in the covariates to have an instantaneous effect on the outcome.

[c] Percent change calculated using a model with unstandardized coefficients to generate correct estimates

[d] Confidence interval. We determined substantive significance using an absolute value cut point, and not a CI, as described in the methods. Confidence intervals are provided as a heuristic.

monogamous partnerships and fewer concurrent sexual relationships (Adimora & Schoenbach, 2002; Buot et al., 2014), changes that would reduce vulnerability to HIV. Future work should investigate these and other possible pathways linking minimum wage, income inequality, and HIV.

4.1. Limitations

Our study has limitations that future studies should address. An ecologic design is appropriate for early investigations into a novel topic, as is the case here. Such a design, however, precludes drawing causal inferences regarding the impact of minimum wages on individual-level HIV diagnoses. Additionally, our outcome was HIV *diagnoses*, not HIV *incidence*; trends in HIV diagnoses may be affected by access to HIV testing as well as the rate of new infections.

An alternative explanation for our main finding may be that the sociopolitical environment that leads to higher or lower minimum wage laws may also shape other community-level factors that affect vulnerability to HIV among black heterosexuals. We attempted to account for potential spuriousness due to unmeasured factors by including state-level fixed effects in our model (Parks, 2012).

The study has some notable measurement limitations. Ideally, our analysis would have focused on people most likely impacted by minimum wage laws. Unfortunately, data access limitations precluded obtaining annual, MSA-level data on the number of HIV diagnoses among black heterosexuals stratified by income or education. We included the percent of the non-Hispanic black adult population (aged 25

Table 4

Comparison of Mediated and Unmediated Models: Multilevel[a] Multivariable Results of Regressing Rates of Newly Diagnosed Cases of Heterosexually Acquired HIV (per 10,000) Among Black Adults (Aged 15–64 Years) on State Minimum Wage and Covariates in 73 Large US Metropolitan Statistical Areas, 2008–2015[b].

	Standardized B (95% CI[c])	
	Unmediated	Gini
Covariate	Final Model	Mediated Model
Average state minimum wage (cost of living and inflation adjusted), $		
Lagged baseline (2007)	-0.42 (-0.58, -0.25)	-0.30[*] (-0.47, -0.12)
Change since 2007	-0.06 (-0.15, 0.03)	-0.06 (-0.15, 0.03)
Possible Mediator[d]		
Gini index		
Lagged baseline (2007)	–	0.21 (0.06, 0.36)
Yearly change since 2007	–	0.07 (-0.05, 0.18)

Note: The outcome was natural log transformed to linearize its association to the covariates.

Health expenditure, % residents uninsured, and syringes exchanged per persons who inject drugs covariates are included in the models presented here.

[a] Two level multilevel model with yearly observations (2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2105) nested within MSA. Model includes state as fixed effect and time function that yielded the smallest AIC (fixed effect quadratic and random linear time).

[b] 2008 to 2015 refers to the timeframe for the HIV diagnoses outcome. Covariates were lagged 1 year and reflect 2007–2014. Covariates were lagged one year because we did not expect a change in the covariates to have an instantaneous effect on the outcome.

[c] CI = Confidence interval. We determined substantive significance using an absolute value cut point, and not a CI, as described in the methods. Confidence intervals are provided as a heuristic.

[d] Mediator that met the bivariate threshold of > |0.20| for the absolute sum of dyad's 2 standardized betas.

[*] Mediator with > 10% change in the magnitude of the minimum wage effect estimate between the unmediated and mediated models.

and up) without a high school diploma to mitigate this limitation, but recommend that future research explore the relationship between minimum wage and HIV diagnoses within the most affected populations of Black adults. An exploratory mediation analysis suggested that incarceration rates did *not* mediate the focal relationship. However, our measure only assessed incarceration rates in the general population, not among black adults. Black men and women are systematically over-represented in correctional systems nationwide, and as a result under-counted in census derived labor statistics (Western et al., 2002; Western, Kleykamp, & Rosenfeld, 2006). Given the historical roots and empirical linkages between labor market inequalities, mass incarceration, and HIV vulnerabilities in black communities(Adimora & Schoenbach, 2002; Buot et al., 2014; Adams et al., 2012), a more precise measure of incarceration rate that accounts for racial disparities is warranted. Additionally, data only permitted examination of the study's focal relationship over a 7-year span, a timeframe that might not allow significant change over time in this exposure. This limitation may plausibly account for why the longitudinal relationship between change in baseline (2007) minimum wage and HIV diagnoses did not meet our statistical cutpoint. Future studies, should adopt a longer study period. Finally, this study focused only on HIV diagnoses attributed to heterosexual contact. Subsequent studies should examine relationships between minimum wage and HIV among black men who have sex with men, a population experiencing the greatest burden of HIV in the US (Friedman et al., 2014).

5. Conclusion

While economists chart the effects of minimum wage laws on unemployment, consumer prices, and labor market trends (David et al., 2016; Neumark & Wascher, 2011; Belman et al., 2016; Sabia, 2008), public health researchers can quantify their effects on population health and health inequities. Though preliminary, this study's findings and the emerging literature on minimum wage and health can shift public policy debates beyond economic discourse to considerations of population health. While biomedical, primary prevention, and health promotion and education interventions remain critical to combatting HIV among black heterosexuals, this study reinforces that public health leaders should also pursue solutions rooted in economic justice and racial equity when developing strategies for ending high burdens of HIV

transmission among black heterosexuals.

Ethical statement

David H. Cloud led the conceptualization and writing of the paper, and Dr. Stephanie Beane led statistical analysis, all under the mentorship of Dr. Hannah LF Cooper and Kelli Komro. All other co-authors provided invaluable assistance and feedback with study methodology, analysis, and editing.

The analysis for this study was approved by the Emory University Institutional Review Board.

Disclaimer

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmph.2018.100327.

References

Adams, S., Blackburn, M. L., & Cotti, C. D. (2012). Minimum wages and alcohol-related traffic fatalities among teens. *Review of Economics and Statistics, 94*(3), 828–840.

Adimora, A. A., et al. (2014). Policies and politics that promote HIV infection in the Southern United States. *AIDS, 28*(10), 1393–1397.

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707–712.

Adimora, A. A., & Schoenbach, V. J. (2005). Social context, sexual networks, and racial disparities in rates of sexually transmitted infections. *The Journal of Infectious Diseases, 191*(Suppl 1), S115–S122.

Adimora, A. A., & Schoenbach, V. J. (2013). Social determinants of sexual networks, partnership formation, and sexually transmitted infections. *The New Public Health and STD/HIV Prevention,* 13–31.

Adimora, A. A., Schoenbach, V. J., & Doherty, I. A. (2006). HIV and African Americans in the southern United States: Sexual networks and social context. *Sexually Transmitted Diseases, 33*(7 Suppl), S39–S45.

Alabama State Conference of the NAACP v. Alabama U.S. District Court N.D. of Alabama.

Anema, A., Vogenthaler, N., Frongillo, E. A., Kadiyala, S., & Weiser, S. D. (2009). Food insecurity and HIV/AIDS: Current knowledge, gaps, and research priorities. *Current HIV/AIDS Reports, 6*(4), 224–231.

Aral, S. O., Adimora, A. A., & Fenton, K. A. (2008). Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. *Lancet, 372*(9635), 337–340.

Averett, S. L., Smith, J. K., & Wang, Y. (2016). The effects of minimum wages on the health of working teenagers. *Applied Economics Letters, 24*(16), 1127–1130.

Belman, D., Wolfson, P., & Nawakitphaitoon, K. (2016). Who is affected by the minimum wage? *Industrial Relations: A Journal of Economy and Society, 54*(4), 582–621.

Bramson, H., et al. (2015). State laws, syringe exchange, and HIV among persons who inject drugs in the United States: History and effectiveness. *Journal of Public Health Policy, 36*(2), 212–230.

Bullinger, L. R. (2017). The effect of minimum wages on adolescent fertility: A nationwide analysis. *American Journal of Public Health, 107*(3), 447–452.

Buot, M. L., et al. (2014). Beyond race and place: Distal sociological determinants of HIV disparities. *PLoS One, 9*(4), e91711.

CDC (2016). *Diagnoses of HIV infection in the United States and dependent areas.* The Centers for Disease Control and Prevention.

Chen, J., et al. (2014). Using quantile regression to examine health care expenditures during the Great Recession. *Health Services Research, 49*(2), 705–730.

Civil and Human (2017). Rights Coalition Lauds Effort to Support Working Families by Raising Federal Minimum Wage to $15 by 2024, T.L.C.f.C.a.H. Rights, Editor, The Leadership Conference for Civil and Human Rights.

Cooper, D. (2015)., Raising the Minimum Wage to $12 by 2020 Would Lift Wages for 35 Million Workers E.P. Institute, Editor. May.

Cooper, H. L., et al. (2008). Estimating the prevalence of injection drug use among black and white adults in large U.S. metropolitan areas over time (1992–2002): Estimation methods and prevalence trends. *Journal of Urban Health, 85*(6), 826–856.

David, H., Manning, A., & Smith, C. L. (2016). The contribution of the minimum wage to US wage inequality over three decades: A reassessment. *American Economic Journal: Applied Economics, 8*(1), 58–99.

Dube, A. (2017). Minimum wages and the distribution of family incomes. I.I.o.L. Economics, Editor.

Friedman, S. R., et al. (2014). Do metropolitan HIV epidemic histories and programs for people who inject drugs and men who have sex with men predict AIDS incidence and mortality among heterosexuals? *Annals of Epidemiology, 24*(4), 304–311.

Gunasekara, F. I., Richardson, K., Carter, K., & Blakely, T. (2013). Fixed effects analysis of repeated measures data. *International Journal of Epidemiology, 431*(1), 264–269.

Harling, G., et al. (2014). Income inequality and sexually transmitted in the United States: Who bears the burden? *Social Science & Medicine, 102*, 174–182.

HIV among African Americans (2017). February, The Centers for Disease Control and Prevention: The Centers for Disease Control and Prevention.

Holtgrave, D. R., & Crosby, R. A. (2003). Social capital, poverty, and income inequality as predictors of gonorrhoea, syphilis, chlamydia and AIDS case rates in the United States. *Sexually Transmitted Infections, 79*(1), 62–64.

Horn, B. P., Maclean, J. C., & Strain, M. R., (2017). Do minimum wage increases influence worker health? *Economic Inquiry, 55*(4), 1986–2007.

Huizar, L., & Gebreselassie, T. (2016). What a $15 minimum wage means for women and workers of color, in Policy Brief, N.E.L. Project, Editor. December.

Johnson, R. C., & Raphael, S. (2009). The effects of male incarceration dynamics on acquired immune deficiency syndrome infection rates among African American women and men. *The Journal of Law and Economics, 52*(2), 251–293.

Kelley, F. (1912). Minimum-wage laws. *Journal of Political Economy, 20*(10), 999–1010.

Khan, M. R., et al. (2009). Incarceration and high-risk sex partnerships among men in the United States. *Journal of Urban Health, 86*(4), 584–601.

Komro, K. A., et al. (2016). The effect of an increased minimum wage on infant mortality and birth weight. *American Journal of Public Health, 106*(8), 1514–1516.

Komro, K. A., Livingston, M. D., Markowitz, S., & Wagenaar, A. C., (2016). The effect of an increased minimum wage on infant mortality and birth weight. *American Journal of Public Health, 106*(8), 1514–1516.

Kronenberg, C., Jacobs, R., & Zucchelli, E. (2017). The impact of the UK National Minimum Wage on mental health. *SSM Population Health, 3*, 749–755.

Lenhart, O. (2017). Do higher minimum wages benefit health? Evidence from the UK. *Journal of Policy Analysis and Management, 36*(4), 828–852.

Levy, H., & Meltzer, D. (2008). The impact of health insurance on health. *Annual Review of Public Health, 29*, 399–409.

Martin, L. L. (2014). Low-wage workers and the myth of post-racialism. *Loyola Journal of Public Interest Law, 405*(16).

McCarrier, K. P., Zimmerman, F. J., Ralston, J. D., & Martin, D. P. (2011). Associations between minimum wage policy and access to health care. Evidence from the behavioral risk factor surveillance system, 1996–2007. *American Journal of Public Health, 101*(2), 359–367.

McGuire, J. T. (2012). The boundaries of democratic reform: Social justice feminism and race in the South, 1931–1939. *The Journal of Southern history, 78*(4), 887–912.

Mills, H. A. (1914). Some aspects of the minimum wage. *Journal of Political Economy, 2*(22), 132–155.

Mutari, E., Power, M., & Figart, D. M. (2002). Neither mothers nor breadwinners: African-American women's exclusion From US minimum wage policies, 1912–1938. *Feminist Economics, 8*(2), 37–61.

Neumark, D., & Wascher, W. (2011). Does a higher minimum wage enhance the effectiveness of the Earned Income Tax Credit? *ILR Review, 64*(4), 712–746.

Parks, V. (2012). The uneven geography of racial and ethnic wage inequality: Specifying local labor market effects. *Annals of the Association of American Geographers, 102*(3), 700–725.

Persons, C. E. (1915). Women's work and wages in the United States. *The Quarterly Journal of Economics, 29*(2), 201–234.

Raissian, K. M., & Bullinger, L. R. (2017). Money matters: Does the minimum wage affect child maltreatment rates? *Children and Youth Services Review, 72*, 60–70.

Reeves, A., et al. (2017). Introduction of a national minimum wage reduced depressive symptoms in low-wage workers: A quasi-natural experiment in the UK. *Health Economics, 26*(5), 639–655.

Sabia, J. J. (2008). Minimum wages and the economic well-being of single mothers. *The Journal of the Association for Public Policy Analysis and Management, 27*(4), 848–866.

Saez, E., & Zucman, G. (2016). Wealth inequality in the United States since 1913: Evidence from capitalized income tax data. *The Quarterly Journal of Economics, 131*(2), 519–578.

Singer JD, W. J. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* Oxford University Press.

Smeeding, T. M. (2005). Public policy, economic inequality, and poverty: The United States in comparative perspective. *Social Science Quarterly, 86*(s1), 955–983.

Tempalski, B., et al. (2013). Trends in the population prevalence of people who inject drugs in US metropolitan areas 1992–2007. *PLoS One, 8*(6), e64789.

Tsao, T. Y., et al. (2016). Estimating potential reductions in premature mortality in New York city from raising the minimum wage to $15. *American Journal of Public Health, 106*(6), 1036–1041.

Van Dyke, M. E., et al. (2018). State-level minimum wage and heart disease death rates in the United States, 1980–2015: A novel application of marginal structural modeling. *Preventive Medicine, 112*, 97–103.

Wehby, G., Dave, D., & Kaestner, R. (2016). *Effects of minimum wage on infant health.* National Bureau of Economic Research.

Western, B., Kleykamp, M., & Rosenfeld, J. (2002). The impact of incarceration on wage mobility and inequality. *American Sociological Review, 67*(4), 526–546.

Western, B., Kleykamp, M., & Rosenfeld, R. (2006). Did falling wages and employment increase U.S. imprisonment? *Social Forces, 84*(4), 2291–2311.

Williams, C. T., & Metzger, D. S. (2010). Race and distance effects on regular syringe exchange program use and injection risks: A geobehavioral analysis. *American Journal of Public Health, 100*(6), 1068–1074.