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Can antipoverty programmes save lives? Quasi-experimental evidence from the Earned Income Tax Credit in the USA

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ABSTRACT

Objective To estimate the impact of state-level supplements of the Earned Income Tax Credit (EITC) on mortality in the USA. The EITC supplements the wages of lower-income workers by providing larger returns when taxes are filed.

Setting Nationwide sample spanning 25 cohorts of people across every state in the USA.

Participants 793 000 respondents within the National Longitudinal Mortality Survey (NLMS) between 1986 and 2011, a representative sample of the USA.

Intervention State-level supplementation to the EITC programme. Some, but not all, states added EITC supplementation to varying degrees beginning in 1986 (Wisconsin) and most recently in 2015 (California). Participants who were eligible in states with supplementary programmes were compared with those who were not eligible for supplementation. Comparisons were made both before and after implementation of the supplementary programme (a difference-in-difference, intent-to-treat analysis). This quasi-experimental approach further controls for age, gender, marital status, race or ethnicity, educational attainment, income and employment status.

Primary and secondary outcome measures The primary outcome measure was survival at 10 years. Secondary outcome measures included survival at 5 years and survival to the end of the intervention period.

Results We find an association between state supplemental EITC and survival, with a HR of 0.973 (95% CI=0.951–0.996) for each US$100 of EITC increase ($p<0.05$).

Conclusion State-level supplemental EITC may be an effective means of increasing survival in the USA.

Strengths and limitations of this study

- We use a quasi-experimental design (a difference-in-difference with intent-to-treat design) that allows for stronger inference than an associational study.
- We use the largest health data set in the USA, which allows us to study individual-level impacts on mortality, a definitive health outcome, over many decades.
- We use a powerful identification strategy that allows us to identify individuals who were eligible for the programme that we evaluate and those who were not.
- Nevertheless, it is possible that states that become rich can subsequently afford other health-producing investments, and these changes in state-level wealth could explain our observed effects.

INTRODUCTION

In the USA, life expectancy has declined relative to other nations for decades as lower wages and higher health costs have reduced disposable income for households below the US median for earnings.[1–3] One policy that has promise to address declining income, and potentially declining health, is the Earned Income Tax Credit (EITC). The EITC is designed to supplement earnings in lower-paying jobs by providing a monetary credit to low-income workers who file taxes. This programme has the effect of restoring some of the disposable income lost to lower-income households as high-paying factory jobs have disappeared in the USA, thereby potentially also restoring health.[4]

The EITC is the largest means-tested anti-poverty programme in the USA.[5] Historically it has received broad bipartisan support, having been created under President Ford in 1975, and subsequently expanded during the terms of Presidents Clinton, Bush and Obama.[6]

Poverty is associated with a greater burden of disease than smoking and obesity combined in the USA.[7 8] Poverty takes a toll on health by increasing one's risk of environmental exposures (eg, living near freeway intersections or living in housing with peeling lead paint) and reducing purchasing power (eg, of healthy food or out-of-pocket medical expenses).[4] Likewise, EITC can increase employment, which is also associated with decreased mortality (possibly because it can increase access to employer-based health insurance, health savings accounts and social capital).[9–12] However, the largest health effects associated with EITC are now believed to arise from incremental changes in psychological stress, which causes

the release of glucocorticoids that damage neural structures associated with executive function, memory and homeostatic processes, such as the regulation of blood sugar and blood pressure.[10 13–18]

Glucocorticoids are meant to increase survival among our hunter–gatherer ancestors by diverting glucose and oxygen from the brain and reproductive organs to muscles, allowing us to flee predators.[19 20] Modern-day society, unfortunately, is filled with stressors that activate these primitive, neurotoxic systems, leading to hypertension, obesity and interfering with health behaviours.[18]

Notably, even small increases in income support among low-income households can lead to increased short-term perceived financial security even if the gains are too small to increase savings (and therefore demonstrable financial security).[10 21 22] Financial security may be one of the most important determinants of stress among low-income households.[16 23–26] By alleviating poverty, the EITC may also serve as a tool for reducing premature mortality in the USA.[9 25]

The hypothesis that EITC might reduce premature mortality is generally supported by previous research, however some studies have shown null findings while at least one other has shown an increase in obesity associated with EITC.[27–35] Therefore, there is reasonable uncertainty as to whether the programme improves health, and there is a strong need for more causal research. Since some states have supplemented federal EITC and some have not, this invites a quasi-experimental analysis in which natural variation in state policies can be used to estimate the impact of state-level supplemental EITC on health or survival. However, to our knowledge, there is only one data set that is capable of identifying large numbers of individuals who are eligible for EITC by their state of residence that also provides longer-term follow-up of their survival effects—the National Longitudinal Mortality Survey (NLMS).[36]

The size of the EITC tax credit varies considerably by family size and marital status. While an adult with no children can earn up to US$400 at tax time, single parent with three children can earn over US$6000. When EITC-eligible individuals are identified, it becomes possible to increase the accuracy of the analysis and to remove confounding of survival outcomes associated with emigration of healthier individuals to wealthier states.[37 38] Long-term follow-up for survival is necessary because EITC-eligible individuals and families tend to be under age 65 and employed, and therefore tend to be healthier. The benefit of reduced exposure to poverty in early-aged and middle-aged adults is only likely to manifest after the age of 65.[39]

The NLMS is the largest mortality survey in the USA, and it allows us to conduct a targeted and comprehensive examination of the impact of state-level supplemental EITC on survival. Others have examined variation by family size[28–31 40] and by state level of supplementation.[34] However, these analyses are limited by assumptions necessary when using smaller and less detailed data sets.

A particular problem faced by some previous quasi-experimental analyses is that it was necessary to look at aggregate state-level effects (eg, among those with family incomes close to the poverty line) rather than effects among individuals with a high probability of EITC receipt. By using the very large and detailed NLMS, administered by the Census Bureau, we are able to identify individuals likely to receive supplemental EITC and to explore dose–response effects within a quasi-experimental design. According to NLMS and Census Bureau officials, ours is the first study to use longitudinal mortality data from the NLMS to assess the impacts of state-level supplemental EITC on survival.

METHODS

Overview

We use survival models to estimate the impact of state-level supplemental EITC on survival. The time frame for our analysis is 1986–2011, with mortality follow-up through the end of 2011. During that time frame, federal and state EITC policies regarding eligible incomes and size of the tax credit changed considerably (table 1). The tax years we analysed were from 1985 to 2010, as the EITC rate applied to tax year t income would benefit the family income in year t+1. Non-recipients were excluded from the analysis.

Each respondent's record in our data set is recorded in person-years, extending from their year of CPS/ASEC interview for the NLMS to their year of exit by death or by reaching the end of mortality follow-up at the end of 2011. We limited our analysis to individuals under the age of 65 because many Americans will have retired by then and are ineligible for EITC. However, mortality follow-up extends beyond this window. A 64-year-old at the time of survey would be followed to 69, 74 or until 31 December 2011 depending on the analysis used.

Patient and public involvement

There was no patient involvement in this study.

Data

While the NLMS contains multiple census data sources, the primary source of data is from the March Annual and Social Economic Supplements of the Current Population Survey. This supplement is an annual survey designed to collect detailed information about income, migration, health insurance and a broader range of general economic data for persons aged 15 years and over. Roughly 60 000 households are interviewed annually in the March CPS. In that survey, one member of each household provides information for all family members.

The March CPS and NLMS are weighted and standardised to be reflective of the US population. The NLMS currently consists of approximately 3.8 million records with over 560 000 identified deaths up through 31 December 2011.[41] We use 793 000 records of adults aged 18–64 over 26 years (1986–2011, all years were included

Table 1 The supplemental EITC benefit by state and the year enacted*

State	Year enacted	Per cent addition to federal EITC
California	2015†	85
Colorado	1999–2013†	10
Connecticut	2011	30
Delaware	2005	20
District of Columbia	2000	40
Illinois	2000	10
Indiana	1999	9
Iowa	1989	15
Kansas	1998	17
Louisiana	2007	3.5
Maine	2000	5
Maryland	1987	25.5
Massachusetts	1997	23
Michigan	2006	6
Minnesota	1991	35
Nebraska	2006	10
New Jersey	2000	30
New Mexico	2007	10
New York	1994	30
Ohio	2013†	10
Oklahoma	2002	5
Oregon	1997	8
Rhode Island	1986	12.5
Vermont	1988	32
Virginia	2004	20
Washington, DC	2000	10
Wisconsin	1989	11

*Details of implementation and variability by family size and year available from TAXSIM.[24 25]
†Not included in analysis as having supplemental EITC because programme implementation was after the period of our mortality follow-up.
EITC, Earned Income Tax Credit.

in our analysis). These data were weighted to be representative of the US population under age 65 at the time of interview. The NLMS data from CPS/ASEC are linked to US death certificates collected by the National Center for Health Statistics via the National Death Index (NDI).

Income cut-offs for supplemental EITC eligibility vary by state. Our information on state EITC cut-offs and eligibility for tax credits comes from source documents generously provided to us by TAXSIM.[42 43] We also added information from the Minnesota Working Family Credit from 1998 to 2010,[44] which differs somewhat from credits offered by other states.

Variables

Eligibility for EITC and the size of the tax credit received by eligible households were estimated using reported family income, marital status, number of children and the rules for supplemental EITC eligibility within each state. We use the March CPS to determine the number of children in each household, the marital status of the householders and the inflation-adjusted household income. We then determine whether a household is eligible for EITC at the federal level as well as the additional credit, if any, for any given state.

Some identification problems that remain: (1) we do not know if the head of household is consistently employed (and thus eligible to claim EITC); (2) how many years of state EITC exposure a given family had, because of (a) moving, (b) divorce, (c) changes in number of kids or (d) pay raises at work and (3) we were unable to estimate the effects of total EITC exposure over time based on the year the state-adopted EITC (due to multicollinearity between year of supplemental EITC adoption and other control variables in the model).

The exposure variables of interest for the survival models are the estimated EITC receipts—'federal EITC' and 'state EITC'—in respondent year (t) from family income earned in year t–1, as reported in the interview in year t. The EITC receipts are calculated from the tax-year-specific formulas from TAXSIM and are applied to the subsequent person-year observation. Both the 'federal EITC' and 'state EITC' receipts are divided into US$100 units to help with the presentation of parameter estimates from the regressions. The EITC receipts are converted into constant 2015 US dollars using the Consumer Price Index (CPI). The year 2015 was used as a year of reference as this was the year in which the variable was created.

To adjust for personal characteristics, we include control variables for (a) age at person-year, (b) sex, (c) marital status, (d) race or ethnicity, (e) educational attainment, (f) income and (g) employment status in addition to the state and federal EITC measures. Other than age, income and EITC receipts, these variables are measured as binary indicators. The descriptive statistics for the proportions of those indicators are shown in table 2 along with the means of the continuous variables. The central tendency is expressed as SD of the continuous variables (SD (x)) and as SE for the proportion (SE (p)).

The categories for sex are men (reference group) and women. For marital status, they are married (reference group) and not married, which includes widows, divorcees, separated persons and the never married. The categories for race and ethnicity are Hispanic, white non-Hispanic (reference group), black non-Hispanic, American Indian/Alaskan native non-Hispanic and Asian/Pacific Islander non-Hispanic. The categories for educational attainment are college degree, some college, high-school diploma (reference group) and no diploma. The categories for employment are employed (reference group), unemployed and 'not in labour force'. These binary indicators are assigned to each person based on

Table 2 Descriptive statistics for lower-income adult PY (ages 18–64 at initial interview) in the NLMS, 1986–2011 (U.S. Bureau of the Census approval DRB approval number CBDRB-FY19-366)

	Maximum follow-up		10-year follow-up		5-year follow-up	
Variable	Mean	(SD (x)) SE (p)	Mean	(SD (x)) SE (p)	Mean	(SD (x)) SE (p)
Age at PY	43.2	(13.5)	41.6	(13.2)	40.5	(13.2)
Female (%)	52.5	0.03	52.2	0.03	52.0	0.05
Married at interview (%)	47.5	0.03	46.5	0.03	45.8	0.04
Race/ethnicity						
Hispanic (%)	15.1	0.02	15.9	0.02	16.5	0.03
White (%)	65.5	0.03	64.3	0.03	63.5	0.04
Black (%)	15.1	0.02	15.2	0.02	15.3	0.03
Native American (%)	0.87	0.004	0.88	0.005	0.86	0.007
Asian/ Pacific Islander (%)	3.5	0.010	3.7	0.013	3.8	0.016
Highest educational attainment at time of interview						
No high-school diploma (%)	20.1	0.02	19.8	0.03	19.3	0.03
High-school diploma (%)	37.7	0.03	37.0	0.03	36.5	0.04
Some college education (%)	26.6	0.03	27.3	0.03	27.7	0.04
College degree or higher (%)	15.6	0.02	16.0	0.03	16.4	0.03
Family income at time of interview, 2015 US dollars (mean, SD)	40 500	(22 500)	40 000	(22 500)	39 500	(22 500)
Family income, 2015 US dollars (as natural log of income at time of interview; mean, SD)	10.2	(1.8)	10.1	(1.8)	10.1	(1.9)
Employment status at time of interview						
Employed	68.0	0.03	67.6	0.03	66.9	0.04
Unemployed	11.2	0.02	11.9	0.03	12.7	0.03
Not in labour force	20.8	0.02	20.5	0.03	20.4	0.04
Receiving state EITC (%)	27.8	0.03	27.2	0.03	27.3	0.04
Federal EITC receipts (in US$100 units; mean, SD)	14.8	(13.0)	15.9	(14.1)	16.3	(14.5)
State EITC receipts (in US$100 units; mean, SD)	3.26	(4.06)	3.29	(4.13)	3.32	(4.18)
Sample size (PY)*	8 820 000		5 960 000		3 530 000	
Sample size (respondents)*	793 000		793 000		793 000	
Number of deaths*	48 000		24 000		12 000	

Results weighted to be representative of the 0–64 US population in 2015.
For Tmax: Conditional means for <fed_eitc>on 2 250 000 PY (206 000 persons), conditional means for <st_eitc>on 281 000 PY (42 500 persons) (correlation is 0.285 among federal EITC recipients).
For T10: Conditional means for <fed_eitc>on 1 540 000 PY (206 000 persons), conditional means for <st_eitc>on 246 000 PY (42 500 persons) (correlation is 0.291 among <fed_eitc>recipients).
For T05: Conditional means for <fed_eitc>on 912 000 PY (206 000 persons), conditional means for <st_eitc>on 168 000 PY (42 500 persons) (correlation is 0.301 among <fed_eitc>recipients).
The statistics in this table have been cleared by the Census Bureau's Disclosure Review Board with release authorisation number CBDRB-FY19-366.
*Sample counts are rounded according to the U.S. Census Bureau Disclosure Review Board Disclosure Avoidance Guidelines.
CBDRB, Census Bureau Disclosure Review Board; EITC, Earned Income Tax Credit; NLMS, National Longitudinal Mortality Survey; PY, person-year.

their response at their CPS/ASEC interview (at baseline) and are used through all person-years. These demographic characteristics are liable to change as a result of exposure to EITC.

Family incomes are asked during their CPS/ASEC interview. The US dollar amount at the time of interview is adjusted to the CPI-adjusted purchasing power of the person-year for calculation of nominal EITC receipts. Both the family income and EITC receipts are then adjusted to year 2015 US dollars in the regression to keep purchasing power constant across the range of the time series. We calculated the state EITC benefits received using income, marriage and number of children. The maximum income for inclusion in the regression sample

also controlled for these variables and the federal EITC income thresholds for various family situations.

To correct for the right-skewed distribution of income, we use the natural logarithm for the variable and assign the value of zero when income is zero or negative. The regression uses age at person-year instead of age at interview to properly adjust for age-relative hazards of mortality.

Model specification

We use Cox proportional hazards models (with state-level fixed effects and errors clustered at the primary sampling unit) to estimate the impact of state-level EITC generosity on 5 years, 10 years and maximum survival among adults (ages 18–64) between 1986 and 2011. State-level fixed effects, coupled with the use of constant (inflation-adjusted) 2015 US dollars, are used to address differences between cohorts at each CPS year of interview. Assumptions for proportionality are met.

We used a difference-in-difference model with an intention-to-treat design, assessing mortality according to people's eligibility for EITC on a state-by-state basis. While eligibility will diverge from receipt of EITC funds, this design is the best way to assess the efficacy of the EITC programme as it actually exists, and discordance between the programme's intended and actual recipients represents an important shortcoming in the programme.

Selecting a length of follow-up time over which to measure EITC's effects on survival presents a conflict, and shorter follow-up times are unlikely to capture EITC's effects on chronic disease and other conditions that may impact long-term survival. However, longer follow-up times introduce more uncertainty about possible changes in the socioeconomic status of the participants in our sample. Since individuals' incomes, household sizes, marital status and states of residence are known only at the time of interview in the Current Population Survey, we do not know how social and demographic variables change over time.

We elected to use 10-year survival rates as our primary outcome measure because it represents a reasonable window for both capturing differences in survival between groups and for minimising error in our identification of EITC eligibility due to changes in family income, marital status or family size (which are increasingly likely with a longer follow-up window). As a sensitivity analysis, we also estimated models with a shorter follow-up window (using 5-year survival as the model outcome) as well as models with a longer follow-up window (using survival rates over the entire follow-up period available for each respondent in the NLMS).

Our set of person-year records consists of those records with 'age at interview' of at least 18 years, and extending up through either (a) 'age at person year' of 64 years, (b) the year of death (with 'failure'=1) or (c) end of follow-up at 2011. An additional inclusion rule includes only respondents with estimated family income that is less than twice the maximum federal EITC income allowed for the respondent's family size. This income limit is to eliminate any possible regression distortions caused by observations on high-income individuals who may have a different mortality risk pattern than the lower-income respondents we wish to analyse.

All models use the NLMS person weights which are divided and distributed among the person-years of the individual. The results of the models report the HRs of mortality for deviations of each independent variable relative to the reference respondent person-year, which would be (a) at the mean age at person-year, (b) men, (c) married, (d) white non-Hispanic, (e) with a high-school diploma, (f) with the average (logged) family income and (g) employed, with US$0 received from federal or state EITC.

RESULTS

In interpreting these results, it is important to consider that our final models differed from their original specification. First, in the original specification, we did not control for state-level fixed effects. State-level fixed effects were added to control for differences in state-level policies that might correlate with state EITC benefits. Second, we had initially used a binary indicator to indicate state EITC receipt. Finally, it was recommended that we use US$100 increments as a tangible unit of measure because some recipients less than US$100 while others might receive thousands of US dollars.

There was significant variation in EITC generosity by state, and there was also a good deal of variation in the time of programme implementation (table 1). Our analytic sample included 793 000 adults aged 18–64 from all 50 states and Washington, DC. Summary statistics for the analytic sample are presented in table 2.

Table 3 shows the results of three Cox proportional hazards regressions. The functional form of, and covariates within, all three regressions is the same but the follow-up time differs (5 years, 10 years and maximum). Our control variables show associations with mortality which are statistically significant at $p<0.001$ and consistent with previous research.[36] For example, mortality risk declines with income and employment but increases with age (table 3). Women have a lower mortality risk than men, and blacks have a much higher risk than whites. Asians have the lowest mortality risk of any group.

State EITC receipt is statistically significant in all three models with a HR=0.973 (95% CI=0.951–0.996) for the 10-year follow-up model. Mortality hazards increased slightly as follow-up time increased (from 0.968 for the 5-year follow-up model (95% CI=0.941–0.995) to 0.979 for the maximum follow-up (95% CI=0.959–0.999)). Federal EITC shows a small but statistically significant increase in mortality hazards in maximal follow-up (1.003, 95% CI=1.001–1005).

Table 3 Cox proportional hazard models of supplemental EITC's impact on mortality risk for lower-income adults for adult person-years (ages 18–64) in the NLMS, 1986–2011 (U.S. Bureau of the Census approval DRB approval number CBDRB-FY19-366)

	Maximum follow-up		10-year follow-up		5-year follow-up	
Variable	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Age at person-year (years)	1.071***	1.070 to 1.073	1.067***	1.066 to 1.069	1.064***	1.062 to 1.066
Female	0.595***	0.576 to 0.614	0.593***	0.571 to 0.616	0.586***	0.559 to 0.614
Married at time of interview	0.692***	0.669 to 0.715	0.685***	0.658 to 0.712	0.686***	0.653 to 0.720
Race/ethnicity (white, non-Hispanic is referent)						
Hispanic	0.588***	0.550 to 0.629	0.590***	0.546 to 0.638	0.600***	0.547 to 0.659
Black	1.086**	1.039 to 1.135	1.091***	1.037 to 1.149	1.085*	1.019 to 1.156
Native American	1.26***	1.10 to 1.45	1.28**	1.10 to 1.49	1.30**	1.08 to 1.56
Asian/Pacific Islander	0.578***	0.509 to 0.657	0.579***	0.500 to 0.670	0.580***	0.486 to 0.691
Highest educational attainment at time of interview (high-school diploma is referent)						
No high-school diploma	1.111***	1.070 to 1.154	1.087***	1.039 to 1.137	1.072*	1.013 to 1.134
Some college education	0.889***	0.850 to 0.929	0.887***	0.842 to 0.934	0.884***	0.829 to 0.941
College degree or higher	0.701***	0.659 to 0.746	0.713***	0.663 to 0.767	0.729***	0.667 to 0.796
Family income, 2015 US dollars (as natural log of income at time of interview)	0.986***	0.977 to 0.995	0.988*	0.978 to 0.998	0.989^{NS}	0.977 to 1.001
Employment status at time of interview (employed is referent)						
Unemployed	3.20***	3.06 to 3.34	3.47***	3.30 to 3.6	3.78***	3.56 to 4.01
Not in labour force	1.79***	1.72 to 1.86	1.91***	1.82 to 2.00	2.03***	1.91 to 2.15
EITC in US$100 units of 2015 US dollars						
Federal EITC	1.003*	1.001 to 1005	1.002^{NS}	1.000 to 1.005	1.002^{NS}	0.999 to 1.005
State EITC	0.979*	0.959 to 0.999	0.973*	0.951 to 0.996	0.968*	0.941 to 0.995
Sample size (n=person-years)†	8 820 000		5 960 000		3 530 000	

All three Cox proportional hazard models include state fixed-effects corrections (state HRs not shown), and time trends based on the year of the respondent's ACS interview.
The statistics in this table have been cleared by the Census Bureau's Disclosure Review Board with release authorisation number CBDRB-FY19-366.
^{NS}Not statistically significant at p≤0.05.
*P<0.05, **p<0.01, ***p<0.001.
†Sample counts are rounded according to the U.S. Census Bureau Disclosure Review Board Disclosure Avoidance Guidelines. All models included n=793 000 respondents.
CBDRB, Census Bureau Disclosure Review Board; EITC, Earned Income Tax Credit; NLMS, National Longitudinal Mortality Survey.

DISCUSSION

In this study, we examine the survival impact of state-level supplements to EITC using a quasi-experimental design and individual-level data for 793 000 adults aged 18–64. After adjusting for age, sex, race, education, family income and employment status, we find evidence for mortality benefits conferred by state-level supplemental EITC.

A HR of 0.97 over a 10-year period of follow-up corresponds to an increase in life expectancy of roughly 2 weeks for every US$100 of state-level EITC supplementation (in constant 2015 US dollars).[45] The results of a recent randomised controlled trial (RCT) suggest that the average eligible recipient might receive hundreds of US dollars in benefits per year, suggesting that the programme has the potential to meaningfully improve population health.[8 35]

We also find very small negative impacts from the federal EITC in one of the three models (a 0.3% increase in hazards). We cannot rule out statistical artefact (collinearity with state EITC receipts, partially systematic residuals over income that ln(income) does not address, an imperfect control for state fixed effects). However, it is also possible that once state-level benefits are controlled for we are picking up the hazards associated with employment (eg, accidents while commuting or on the job) which are independent of the credits themselves.

Strengths and limitations

Our study explores temporal and spatial variation in outcome measures across states as well as dose–response effects across individuals. The NLMS affords a very large sample size, long-term mortality follow-up and information on EITC eligibility at the individual level, providing

a good deal of resolution relative to a previous study that examined aggregate state-level effects.[34] Moreover, since the sample size is very large and the NDI covers all states, it is possible to identify individual-level effects, and to do so irrespective of where the individual died. We were able to identify those participants who were eligible for EITC using TAXSIM and to compare across states that did and did not have supplemental programmes. Our study is consistent with previous studies, which showed that, while EITC receipt may be a risk factor for obesity, overall health and survival benefits have been noted.[27–33 35 40]

However, our study is subject to a number of important limitations. First, it is difficult to precisely estimate the survival benefit associated with EITC because we were unable to quantify the number of years that any given participant was exposed to the credit. Moreover, while quasi-experimental in nature, there could be state-level factors that confound estimates (eg, states with EITC supplementation may also offer other social welfare programmes, offer fewer worker protection regulations or be more likely to receive healthy migrants from other states). On the other hand, federal regulations have disproportionately benefited poorer states that are less likely to implement supplemental EITC because these states have historically been high risk, low regulation. Despite the potential for states to implement EITC in ways that may also correlate with mortality, our quasi-experimental design coupled with controls for income and employment produces estimates that should have a much higher degree of internal validity than associational studies.

Additionally, our results include both states with refundable tax credits and non-refundable tax credits. While we know which states offer refundable or non-refundable credits, we simply do not know enough about individual household deductions or eligibility for other credits to know when non-refundability is a constraining limit or not, or how large a portion of the credit is retained by the state (on average) when there are non-refundability rules. What we do know is that non-refundable credits mean that our calculated benefits represent the top-level estimate of state EITC receipts, so that our test for a significant effect (possibly from a smaller number of state EITC benefit US dollars) is conservative (ie, less likely to produce a low p value). Finally, in a related limitation, we only observe EITC receipt in the year that the participant was interviewed, but record deaths no matter which state they occurred in. To the extent that a participant moved from a state with benefits to one without (or vice versa), the signal in our estimate is weakened, again rendering the estimate more conservative.

CONCLUSIONS

While the EITC is an effective antipoverty programme, it tends to provide fairly modest income support.[8] These modest programme effects may be offset by the fact that the vast majority of people who apply for EITC remain on EITC for many years.[46] The cumulative effects the income support provided by EITC over the years may therefore add up to survival benefits over time. Nevertheless, a recent RCT showed that just 3 years of exposure to supplemental income from EITC can produce measurable impacts on health-related quality of life, at least among women.[26]

Our findings are important from a policy perspective. There is now reasonable evidence that America's declining health and life expectancy are related to the declining fortunes of lower-class and middle-class families.[47] While some of the decline must be addressed with structural changes to the health system[3] and other anti-poverty policies,[25 48] we find encouraging evidence that expanding the EITC could produce significant benefits for health.

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