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Saving Babies: The Impact of Public Education Programs on Infant Mortality

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Abstract We take advantage of unique data on specific activities conducted under the Sheppard-Towner Act from 1924 through 1929 to focus on how public health interventions affected infant mortality. Interventions that provided one-on-one contact and opportunities for follow-up care, such as home visits by nurses and the establishment of health clinics, reduced infant deaths more than did classes and conferences. These interventions were particularly effective for nonwhites, a population with limited access to physicians and medical care. Although limited data on costs prevent us from making systematic cost-benefit calculations, we estimate that one infant death could be avoided for every $1,600 (about $20,400 in 2010 dollars) spent on home nurse visits.

Keywords Infant mortality · Public health · Sheppard-Towner · U.S. Children's Bureau

Introduction

Infant mortality in the United States declined significantly over the first part of the twentieth century, as shown in Fig. 1, which plots infant mortality rates in the birth registration area (BRA) from 1915 to 1940.[1] Rising incomes, improved nutrition and housing conditions, and public infrastructure improvements, such as water sanitation and sewer systems, all contributed to the decline in infant mortality rates, particularly in urban areas (see Cutler and Miller 2005; Ferrie and Troesken 2008; Fogel 1994; Haines

[1] Infant mortality trended strongly downward despite the fact that the BRA continued to expand until 1932 and many of the states that entered later had higher mortality rates than earlier entrants. Figure 1 also plots infant mortality for only those states that were in the BRA as of 1915 to show that the addition of later states does not obscure the strong downward trend. We include this graph to illustrate the trend in infant mortality, but we acknowledge that there are difficulties associated with comparing infant mortality across time, as discussed in Condran and Murphy (2008).

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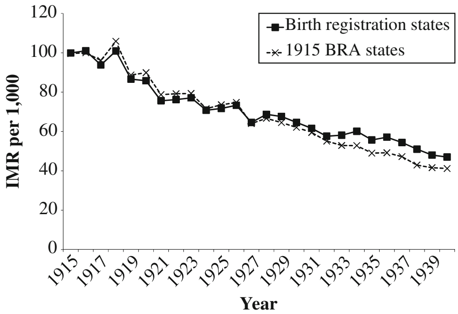

Fig. 1 Infant mortality in the birth registration states and for the registration states of 1915, 1915–1940. Data are from Linder and Grove (1947). The chart shows the overall infant mortality rate (deaths of children younger than 1 year per 1,000 live births)

2001; McKeown 1976). In addition, government expenditures on public health and education increased dramatically over this period. Miller (2008) found that increases in state and local public health and education expenditures prompted by the enactment of women's suffrage decreased mortality from infectious diseases between 1900 and 1936. Fox (2011) used municipal data on public health expenditures over the period 1923–1932 and also concluded that public health spending lowered infant mortality, although the effect was diminished by the inclusion of city-specific time trends in his model.

The literature on infant mortality in developing countries today similarly provides mixed findings on the effectiveness of public health expenditures. Several studies have shown that public health expenditures have a minor or statistically insignificant impact on infant and child mortality (Aiyer et al. 1995; Filmer et al. 1998; Filmer and Pritchett 1997; Kim and Moody 1992; McGuire et al. 1993; Musgrove 1996), while others (Anand and Ravallion 1993; Anyanwu and Erhijakpor 2009; Gupta et al. 2002; Hojman 1996) have suggested that such expenditures lead to substantial decreases in infant deaths. However, expenditure levels are very crude measures of the extent of public health interventions. Governments may engage in a wide range of public health activities, and these activities may vary greatly in their effectiveness. For instance, home visits by nurses may be expected to have a different effect than health fairs or conferences. Focusing on only expenditure measures misses this important variation. The mixed findings in the literature may reflect the variation in how public health dollars are spent.

We take advantage of unique data on the number and types of specific public health education activities that occurred during a 1920s U.S. federal program called Sheppard-Towner to shed light on the effectiveness of public health education programs in reducing infant mortality. While most of the expansion in public health programs in the United States in the early part of the twentieth century occurred at state and local levels, the federal government was also involved in public health initiatives. The U.S. Children's Bureau conducted studies of infant mortality in a variety of areas in the United States and compared its findings with data on infant mortality in other advanced economies.

After declaring 1918 as the "Children's Year," the Bureau sought to reduce infant and child mortality by distributing literature and by providing education on health and hygiene at fairs. Efforts to implement a broader and more permanent program aimed at providing prenatal and infant care education finally succeeded in 1921, when Congress passed the Promotion of the Welfare and Hygiene of Maternity and Infancy Act, more commonly known as the Sheppard-Towner Act.[2]

Sheppard-Towner provided matching money to states to spend on public health programs targeted at reducing infant and maternal mortality. Each participating state received $5,000 outright and then received dollar-for-dollar matching funds up to an explicit cap determined by its population. States used funds from the program in a variety of ways. Some states used Sheppard-Towner money to organize conferences where physicians and other health professionals would examine children and pregnant women or provide demonstrations on maternal and infant care and hygiene. Many states provided classes for midwives as well as infant-care classes for girls. Several states sent "prenatal letters" to pregnant women, and some paid public health nurses to visit new and expectant mothers. Some also used the funds to establish public health clinics.

Opposition from the American Medical Association and others led to the repeal of the Sheppard-Towner Act in 1929. Even though the program was short-lived, the Children's Bureau heralded it as a success and concluded that "the value of maternity and infancy work is reflected in the decrease in infant and maternal death rates in 1928 as compared with those in 1921" (U.S. Children's Bureau 1931a:6). This claim has been echoed by historians such as Molly Ladd-Taylor, who wrote, "A further indication of the program's success was the significant decrease in infant mortality during the Sheppard-Towner years" (Ladd-Taylor 1994:187). On the other hand, infant mortality was trending strongly downward even before 1920. Opponents of Sheppard-Towner disputed its effect and attributed the decline in infant mortality to the preexisting trend. A 1932 editorial in the *Journal of the American Medical Association* (JAMA) highlights this view:

> During the seven and one-half years that the Sheppard-Towner Act was in effect, it cost the people about eleven million dollars in taxes. During that entire time it did not develop a single new idea in the field of maternal and infant hygiene. As shown by the official mortality statistics, it did not accelerate the rate of decline in either the maternal or the infant death rates, by even a fraction of a point per annum. (JAMA 1932:404)

An important feature of Sheppard-Towner for the purposes of this study is that states were required to file annual reports with the Children's Bureau detailing the activities undertaken under the program's auspices. For each program year between 1924 and 1929, we know not only the amount of the grant accepted but also the number of home nurse visits made, the number of prenatal and child health conferences organized, the number of health centers established, the number of midwives enrolled in classes, and even the number of prenatal letters distributed. These activities involved very different levels of interaction with mothers and children and therefore may have had differential impacts on infant mortality. Thus, we separately analyze the effects of these activities rather than just looking at aggregated expenditure levels.

[2] Prior to Sheppard-Towner, the federal government had also provided money to states to assist in venereal disease control and prevention under the Chamberlain-Kahn Act of 1918.

To account for the persistent differences in mortality environments across states and the strong downward trend in infant mortality of the period, we include state fixed effects and state-specific time trends in all our models. We find that the type of public health intervention mattered. More direct and personal interventions—nurse visits, for example—were most effective at reducing infant mortality, whereas conferences and classes had little impact. Moreover, we find a differential effect of Sheppard-Towner interventions on nonwhite and white infant mortality. Specifically, establishing public health centers and funding nurse visits to mothers generated much larger reductions in infant mortality for nonwhites than for whites. In addition, although prenatal letters reduced white infant mortality, they did not reduce nonwhite infant mortality.

The limitation of the Sheppard-Towner data is the lack of data on costs per activity. Although many at the Children's Bureau believed such cost estimates would be valuable, attempts to collect such data from the states were not successful. In 1926, the directors of state divisions of child hygiene were asked to provide data on the costs involved in different activities with the hope that a "proper cost-accounting system" could be developed. At the Fourth Annual Conference of State Directors in Charge of the Local Administration of the Maternity and Infancy Act, S. Josephine Baker, a medical doctor and consultant for the Children's Bureau, reported on the wide variety of cost estimates obtained from the states and the difficulties in developing standardized measures. In her own words,

> The factors of population density, areas to be covered, the number of mothers and babies who can be reached within any given limit of time, and the complicated elements of ignorance or social and racial maladjustment provide a background which is so complex that it has not yet been possible for us to speak of standardized unit costs for this type of work with any degree of assurance or finality. (U.S. Children's Bureau 1927b:109)

In the discussion following Baker's report, many state administrators, as well as Grace Abbott, the Chief of the Children's Bureau, expressed the sentiment that producing such cost estimates would be complicated and expensive and the potential benefits small (115). Thus, although it would be desirable to calculate the effects of a dollar spent on different activities, we are unable to do this systematically for all activities. Nevertheless, we are able to make such a calculation for one of the most effective but expensive interventions: home visits by nurses. We find that one infant death could be averted for every $1,600 (about $20,400 in 2010 dollars) spent on home visits by nurses.

We also use our results to estimate the overall effectiveness of the Sheppard-Towner program. Educational programs, like those funded by Sheppard-Towner, are still promoted today as ways to decrease infant mortality, yet we do not know if and how such activities contributed to the dramatic reduction in infant mortality that occurred in the United States during the early twentieth century.[3] We conclude that although much of the reduction in infant mortality during the 1920s must be attributed to other factors, activities funded by Sheppard-Towner accounted for between 9 % and 21 % of the decline.

[3] See, for instance, Bill and Melinda Gates Foundation (2013).

Infant Mortality and the U.S. Children's Bureau

Created in 1912, the Children's Bureau was charged with investigating and reporting "upon all matters pertaining to the welfare of children and child life among all classes of our people" (42 U.S.C. Ch. 6, April 9, 1912). In the 1910s, the Children's Bureau focused on studying causes of infant and maternal mortality and creating a birth registration area where all births would be accurately and consistently reported. An examination of nearly 23,000 infants in eight cities led the Children's Bureau to conclude that the overall infant mortality rate in the United States was 111.2 deaths per 1,000 live births, a rate higher than those of many other industrialized countries. Moreover, many of these deaths were believed to have been preventable. For example, the study revealed that the mortality rate for artificially fed infants in the first nine months of life was 4.8 times greater than for breast-fed infants (Woodbury 1925:91). Overall, about 29 % of the deaths were attributable to gastric and intestinal causes, many resulting from improper feeding and hygiene (Woodbury 1925:14).

The Children's Bureau investigations also revealed that large numbers of rural women had limited access to medical care during childbirth. In its study area in rural Wisconsin, the Bureau found that half of confinements were attended by midwives, and 8 % were attended by neighbors or relatives without any training. Moreover, in a number of cases classified as attended by a physician, the physician had arrived only after the birth. In one case, a new mother had to wait two hours for the doctor to arrive to cut the umbilical cord (Sherbon and Moore 1919:28–30). In a homesteading county in Montana, the conditions were even worse: more than one-half of the new mothers studied lived more than 20 miles from the nearest physician (Paradise 1919:27).

As a result of these studies, the chief of the Children's Bureau, Julia Lathrop, proposed a plan for the "public protection of maternity and infancy" with federal funds. The plan called for greater instruction of mothers on the care of infants and greater availability of physicians and hospital care. Instruction could be provided through public health nurses, universities, and extension teaching. Lathrop suggested that the Smith-Lever Act of 1914, which funded cooperative agricultural extensive work, provided a precedent by which the federal government could fund the program using matching grants to states (U.S. Children's Bureau 1917:47–49).

Although the first bill of what finally became the Sheppard-Towner Act was introduced in 1918, it was not until after women's suffrage in 1920 that the program finally became law. The primary opponents to the bill were the American Medical Association (which feared nonmedical control of medicine) and anti-suffragists. Historians argue that Sheppard-Towner passed because members of Congress feared the new, unknown voting power of women. The effectiveness of the women's lobby and the fear of the House and Senate was noted by Senator Kenyon (R-Iowa), who stated, "If the members could have voted on that measure secretly in their cloak rooms it would have been killed as emphatically as it was finally passed in the open under the pressure of the Joint Congressional Committee of Women" (Selden 1922:95). The idea that Congress had at least some fear of the women's vote is supported by findings from other studies. Lott and Kenny (1999), for example, found that suffrage coincided with immediate increases in state government expenditures for functions women generally supported, such as education, sanitation, and hospitals. Suffrage also generated more-liberal voting patterns among federal representatives. Miller (2008) similarly found that suffrage laws generated large increases in public health spending. Moehling and Thomasson (2012) also found that the timing of women's suffrage had a large impact on the level of state participation in the Sheppard-Towner program.

The political debate did not end after enactment, however. When the program came up for renewal in 1926, it met with increased opposition, particularly from the American Medical Association. Politicians' fears about the women's vote had also diminished as it became clear that women did not vote as a block. Ultimately, a compromise was reached in which the program was extended for two years but then was automatically repealed in 1929.[4]

Under the auspices of Sheppard-Towner, states had the autonomy to engage in a variety of activities designed to reduce infant and maternal mortality and improve the health of children and mothers. During the seven-year period in which the act was in force, physicians conducted 144,777 conferences in which they examined children and pregnant women, and nurses and dentists held nearly 40,000 more conferences in which they provided general instruction on maternal and child care. At these itinerant conferences, health professionals used lectures, motion pictures, and exhibits to provide instruction on the care of infants and children. They also examined infants and preschoolers and referred those with problems to physicians (U.S. Children's Bureau 1931a:2).

In addition, states and counties set up 2,978 permanent child and/or prenatal health centers where mothers could bring children to be examined and receive follow-up care.[5] Public health nurses visited more than 3 million women and their children in the last six years of the act. During these visits, field nurses advised women on child care and examined children. Nurses could provide demonstrations in the household "... with the equipment the home affords," and make additional recommendations upon seeing the living conditions of the family (U.S. Children's Bureau 1926a:7). The Children's Bureau noted that the informal setting of the visits also may have made mothers feel more free to ask questions and may have been particularly useful in isolated communities with a lack of access to medical care and where it was difficult to arrange conferences (U.S. Children's Bureau 1926a:7).

Sheppard-Towner funds were also used to provide literature on prenatal and child care to expectant women and mothers. The Children's Bureau studies in the 1910s found that many mothers, especially those in rural areas, looked to printed material for guidance on child care (Apple 2006:77–78). More than 22 million pieces of literature (such as instructional pamphlets and prenatal letters) were distributed nationwide when the act was in force. In the last four years of the act alone, the Children's Bureau estimated that more than 4 million infants and children and about 700,000 pregnant women were reached by some form of the public health work conducted under Sheppard-Towner (U.S. Children's Bureau 1931a:2).

Data and Methods

The overall U.S. infant mortality rate in 1922 was 76.2 deaths per 1,000 live births. By the time Sheppard-Towner was repealed in 1929, the infant mortality rate had fallen to

[4] For more discussion of the political economy of Sheppard-Towner, please see Ladd-Taylor (1994), Lemons (1969, 1990), Lindenmeyer (1997), Meckel (1990), Moehling and Thomasson (2012), and Skocpol (1994).

[5] These permanent health centers were not necessarily newly constructed, stand-alone clinics. They often were just regularly scheduled sessions where physicians and nurses would see patients in a given location. For example, some states used rooms in municipal buildings or schools (U.S. Children's Bureau 1927a:10).

67.6 (Linder and Grove 1947:574–575). How much, if any, of this decline can be attributed to the activities in which states engaged under the Sheppard-Towner program? Although Sheppard-Towner was passed in 1921, it took many states a couple years to gear up to accept federal grants and establish programs. Not until its report on the Sheppard-Towner Act for the 1924 fiscal year was the Children's Bureau able to give a systematic accounting of the activities of the states. The Children's Bureau published these data in tabular form and provided annual state-by-state reports starting in 1925 (U.S. Children's Bureau 1925, 1926a, 1927a, 1928, 1929, 1931b). These reports allow us the rare opportunity to construct a data set on state public health education activities rather than just expenditure levels. For periods before and after Sheppard-Towner, the only systematically collected state-level data on public health programs are the cost outlay data provided in the U.S. Census Bureau's *Financial Statistics of States*. As discussed later in the article, the differences in the accounting and reporting practices of state governments mean that these data are not necessarily comparable across states or over time.

Given the administration of Sheppard-Towner, we are relatively confident that the Children's Bureau reports provide an accurate accounting of the state activities funded by the program. Under the act, states were required to report on the activities they performed during the year. In conference proceedings, several states referred to how they kept track of "routine" work and work done under the "maternity and infancy" act. For example, the Director of the Bureau of Child Hygiene and Public Health Nursing in Alabama described receiving appeals from county health officers regarding how to ensure that a public health nurse devoted the correct amount of time to duties assigned to her under the Sheppard-Towner program when she had other duties to perform as well. To such appeals, the Director responded by instructing, "Use your common sense and let your conscience be your guide. You will be required to keep accurate and complete records of all your activities and to make monthly progress reports which are based on these records. The reports and the individual record cards on file in your office will be open to inspection for purposes of analysis and study at all times" (U.S. Children's Bureau 1926b:190).

More difficult to determine, though, is the degree to which the activities funded by Sheppard-Towner grants were new initiatives for states as opposed to long-standing programs for which the costs were shifted from general revenues to the federal grants.[6] For this reason, we limit our analysis to the period of 1924 to 1929, for which we have the full accounting of maternal and infant health initiatives funded by Sheppard-Towner. Expanding the panel to include years before 1924 would require assuming that the public health activity levels were zero for these years, an assumption that is clearly false for many states.[7]

[6] Moehling and Thomasson (2012) discussed evidence of such cost shifting by the states of New Jersey and North Carolina.

[7] We also estimated the model over the periods 1922–1929 and 1915–1929 (excluding the years of the influenza pandemic), making the assumption of zero activity levels for the years prior to 1924. The results were similar to those reported in this article. The degree of cost shifting may have varied across states. As long as states engaged in consistent levels of cost shifting from year to year, the state fixed effects included in the model will account for this variation. However, states may have engaged in different levels of cost shifting from year to year. This would mean that the year-to-year variation in the activity levels reported by the Children's Bureau could overstate the true variation. Such variable cost shifting would bias the results against finding statistically and economically significant effects of the Sheppard-Towner activities on infant mortality.

We use state-level vital statistics data on the infant mortality rate (defined as the number of deaths of children less than 1 year old per 1,000 live births) to test whether the public health activities funded by the Sheppard-Towner program had the life-saving effects the Children's Bureau claimed. The infant mortality rate in a state depends on demographic characteristics of the state's population (such as racial composition and the fraction living in large cities), public infrastructure (such as water and sewer systems), and industrial activities as well as the climate. For the most part, these characteristics are fixed or subject to only small changes over the six years of our study. Therefore, we deal with these factors empirically by including state fixed effects in our model. These fixed effects will capture any differences in infant mortality caused by differences in state characteristics that do not vary over time, such as climate. Because infant mortality was trending downward before and after the Sheppard-Towner period, we also include state-specific time trends to allow for differences across states in these trends in infant mortality. For example, it is possible that some states during this period may have engaged in public infrastructure projects related to sanitation that affected infant mortality, while others did not. Finally, we include year fixed effects to capture any temporal variation that was common across states, such as the state of medical technology.[8]

Our basic model is as follows:

$$IMR_{it} = \alpha + \left(\beta \times ST_{it}\right) + \delta_i + \delta_t + \left(\delta_i \times t\right) + \varepsilon_{it}, \tag{1}$$

where IMR_{it} represents the infant mortality rate in state i in year t, ST_{it} represents the measure of Sheppard-Towner activity for state i in year t, δ_i and δ_t are the state and year fixed effects, and $\left(\delta_i \times t\right)$ represents the state-specific linear time trend. Because this model accounts for differences across states in both levels and trends in mortality rates, the effects of Sheppard-Towner activities are identified from the deviations from those trends. In the fully saturated specification, β is identified by the within-state deviations from trends in Sheppard-Towner activities.

As noted earlier, states engaged in a wide range of activities with Sheppard-Towner funds. States utilized Sheppard-Towner money to establish health clinics, to conduct prenatal and child health conferences (where physicians or nurses examined children and provided information about hygiene and nutrition), and to send public health nurses into homes to examine children and educate mothers. In addition, states used these funds to provide training for midwives and to disseminate free literature on prenatal and infant care. These different forms of activities involved very different types of interactions with mothers and their children, and we might expect that some would have a greater impact than others on mortality rates. We first examine the impact of each of

[8] We also estimated all models including state income per capita and the number of federal income tax returns filed per capita to capture the effects of rising income and changing income distributions over this period. These data were generously provided by Price Fishback. In none of the estimated models, however, could we reject the hypothesis that these variables had no effect on infant mortality after allowing for state and year fixed effects and state time trends. In addition, the inclusion of these variables did not substantively alter the estimated effects of the Sheppard-Towner activity measures.

these activities (in per capita terms) separately and then estimate a model including all of them.

One concern may be that the measure of Sheppard-Towner activity is endogenous; a state's decision to participate in Sheppard-Towner or to engage in a particular activity may have been influenced by its infant mortality rate. In other words, the error terms for models of a state's Sheppard-Towner activity levels may be correlated with the error term in Eq (1). However, this will be a problem for the estimation of β in Eq. (1) only if the correlation is due to something other than state and year fixed effects and the state-specific linear time trend.

The model as described in Eq. (1) assumes that a public health intervention would have an effect on infant mortality in the relatively short run; β captures the impact of an activity carried out in year *t* on infant mortality in year *t*. For most activities carried out with Sheppard-Towner funds, we would expect the greatest effects on infant mortality to occur in a relatively short period of time. Most of the interventions took place during pregnancy or shortly after birth, and infant mortality is defined as death within the first year of life. In addition, the nature of the data allows for a 6- to 18-month lag between a public health initiative and its impact on infant mortality. Whereas the infant mortality data are reported for the calendar year, the Sheppard-Towner data are reported for the federal government's fiscal year, which ran from July 1 to June 30. In other words, the model as estimated assumes that Sheppard-Towner activities taking place between July 1 of year $t-1$ and June 30 of year *t* would affect infant mortality over the period January 1, year *t*, to December 30, year *t*.[9]

Although we think that the data on Sheppard-Towner activities provide a more detailed view of public health initiatives aimed at infant mortality than do data on expenditures, we also look at more commonly used financial measures of public health engagement so that we may compare our results with previous studies. First, we consider the federal Sheppard-Towner grant amount accepted per capita. Because of the $5,000 unmatched component of the program and the variation in participation, this measure varies substantially across states. However, it may be a poor measure of the impact of Sheppard-Towner on state public health initiatives because some states may have simply shifted expenditures from existing public health categories into Sheppard-Towner to qualify for the federal match.[10]

We also estimate models in which we use data from the U.S. Census Bureau's *Financial Statistics of States* (1925–1930) on cost payments for the broad category of "conservation of health and sanitation" as well as for the subcategory of "conservation of child life." Programs that fall in the category of "conservation of child life" would include most of the Sheppard-Towner-funded activities but would also include programs aimed at school-age children. The "conservation of health and sanitation" category would include the full range of public health programs and sanitation projects in which a state engaged.

The *Financial Statistics* data have been used by other scholars as measures of variation across states in engagement in public health and social welfare programs

[9] As a robustness check, we also estimated models including one-year lags of the Sheppard-Towner activities. The lagged activity measures did not have statistically significant effects on infant mortality rates.

[10] New Jersey was quite open about the fact that it used the federal grants to replace state appropriations. For instance, in 1922, the New Jersey legislature appropriated almost $100,000 less for the Department of Health than it had in 1921. This move was explained in the Department's annual report in quite plain terms: the appropriations for the Bureau of Child Hygiene and the Bureau of Venereal Disease Control were being reduced because both would be receiving federal monies for their work (New Jersey Department of Health 1922:19).

(Lott and Kenny 1999; Miller 2008). However, the Census Bureau cautioned about the limitations of these data for comparing states' expenditures:

> In making comparisons of the data for individual States . . . it should be noted that while the payments shown for the main groups of departments or divisions are fairly accurate, and hence comparable, those for some of the individual objects of expenditure are less exact. Where a segregation of the items of expense for the different functions is not made by the local authorities, it is often difficult or impossible for the agents of the Bureau of the Census to secure correct statistical data. (U.S. Census Bureau 1926:28)

This would suggest that, although the data for the major division of health and sanitation are comparable across states, the data for the subcategory of the conservation of child life may suffer from differences in how states disaggregated and reported public health expenditures. However, for the 1924 data, the Census Bureau also specifically pointed out a problem in making comparisons across the major divisions of expenditures as well. During that year, many states had engaged in programs to prevent the spread of tuberculosis. The Census Bureau intended such expenses to be included as part of the health department outlays, but noted that for several states, these expenses were included in the payments for hospitals and outdoor poor relief (charitable assistance to individuals outside institutions) (U.S. Census Bureau 1926:28).[11] The comparability problems arising from differences across states in accounting and reporting practices suggest that the conservation of child life and health and sanitation expenditure variables suffer from some degree of measurement error. The fact that this measurement error would tend to bias downward the estimates of these variables on infant mortality provides another reason to prefer using the Sheppard-Towner activity data to gauge the effectiveness of public health interventions.

We estimate Eq. (1) for all infants, and also separately for whites and nonwhites. Vital statistics data provide infant mortality rates only for states in the BRA. At the start of our study period in 1924, 33 states were in the BRA; by 1929, that number had jumped to 46.[12] To make the most of the available data, we estimate Eq. (1) using the unbalanced panel of all states in the BRA for at least one year of the study period.[13]

The nonwhite infant mortality rate at the beginning of the period was nearly twice that of white infants, as shown in Fig. 2. Despite the fact that more states with high infant mortality rates for nonwhites were entering the BRA during this period, the racial

[11] Another challenge for making comparisons across states when using the *Financial Statistics* data is the difference in timing of the "fiscal year" for different states. Although most states defined their fiscal year to match that of the federal government, many states used alternative definitions. In fact, in some states, the definition of the "fiscal year" varied across departments (U.S. Census Bureau 1926:13).

[12] To be included in the BRA, a state had to have a systematic procedure in place for recording all births. When the BRA was established in 1915, it consisted of only 10 states. Following is a list of the states that entered the BRA during the study period, along with their years of entry: West Virginia (1925); Arizona (1926); Alabama, Arkansas, Louisiana, Missouri, and Tennessee (1927); Colorado, Georgia, and Oklahoma (1928); and Nevada and New Mexico (1929). South Carolina was part of the BRA in 1924, was dropped in 1925, and then was readmitted in 1928. The two states not part of the BRA by 1929 were South Dakota and Texas (Linder and Grove 1947:97).

[13] We also estimated all models using the balanced panel consisting of states in the BRA for all five years; the basic findings did not change. All estimated models we present in this article include the three states that did not participate in Sheppard-Towner: Connecticut, Illinois, and Massachusetts. Excluding these states does not alter the basic findings.

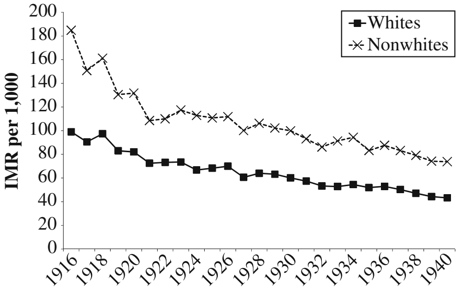

Fig. 2 White and nonwhite infant mortality: 1916–1940. Data are from Linder and Grove (1947). The chart shows the overall infant mortality rate calculated as deaths of children younger than 1 year per 1,000 live births

gap in infant mortality rates did not widen appreciably. *A priori*, we did not know whether Sheppard-Towner spending would affect blacks and whites differently. Sheppard-Towner initiatives were targeted at smaller cities and rural areas. Some interventions, such as classes to train midwives, may have benefited blacks more than whites, given that the vast majority of Southern blacks used midwives (Ladd-Taylor 1988:263). On the other hand, the structure of Sheppard-Towner may have limited the effectiveness of the interventions for blacks. For example, although stricter regulation of midwives and midwife classes may have improved the quality of some midwives, the regulations may have driven many midwives underground and out of business, thus limiting the ability of blacks to find birth attendants (Ladd-Taylor 1988:269–270).

In addition, we may expect differential effects of the education programs because of the higher illiteracy rates and lower education levels of black women compared with white women. According to the 1920 census, the illiteracy rate for black females aged 10 and older was 22 %, compared with only 4 % for white females (U.S. Census Bureau 1922:1151). One Children's Bureau study conducted in Mississippi indicated that 8 out of 295 white mothers visited by public health nurses were illiterate, compared with 100 out of 380 black mothers (Dart 1921:15). In Grossman's (1972) model of health capital, education can impact health directly because more-educated people may know more about producing health, or indirectly if more-educated people can better combine other inputs to produce better health.

Of further concern is that the decentralization of Sheppard-Towner administration may have reinforced the ability of racist public health workers to discriminate against blacks at the local level. By helping whites and not blacks, these practices may have increased the racial gap in infant mortality.[14] Or, racism could have worked *in favor* of blacks. Troesken (2004) argued that public officials improved water and sewer systems in black neighborhoods in order to protect white neighborhoods from the negative externalities blacks may have generated had sewer systems been unavailable to them. State reports to the Children's Bureau documented efforts to target blacks as well as other minority groups rather than to exclude them. In 1924, for instance, Alabama paid for a black nurse to join the Tuskegee Movable School. The nurse joined a carpenter, instructor, and agriculturist who traveled around the state teaching black rural families

[14] The widening of the racial gap in infant mortality later in the twentieth century can be attributed to the fact that whites had better access to improved medical care than blacks (see Almond et al. 2006).

how to improve their homes and their health (U.S. Children's Bureau 1925:21). In the same year, Florida reported making more prenatal visits to black women (4,033) than to white women (2,406) (U.S. Children's Bureau 1925:24).

Results

Summary statistics are provided in Table 1. The mean of the white infant mortality rate in the BRA over the period is about 70 deaths per 1,000 live births, while the nonwhite infant mortality rate is 128. The means hide considerable variation, so we report the minima and maxima of the variables as well. For example, the mean number of nurse visits per 1,000 population is 6.65, with a minimum of 0 and a maximum of 139.

Table 2 reports the results of the estimation of Eq. (1) for overall infant mortality rates from 1924 to 1929. The first two columns present the estimated coefficients and

Table 1 Descriptive statistics of state-level variables used in regression models, 1924–1929

Variable	Obs.	Mean	SD	Min.	Max.
Infant Mortality Rate (per 1,000 births)					
Overall	231	69.99	14.00	46.60	145.50
White	231	65.65	12.38	45.20	142.00
Nonwhite[a]	219	128.25	45.96	47.60	318.20
Sheppard-Towner Activities (per 1,000 in population)					
Home nurse visits	231	6.65	17.62	0.0000	138.85
Conditional on > 0	122	12.60	22.68	0.0190	138.85
Midwives enrolled in classes	231	0.15	0.59	0.0000	6.90
Conditional on > 0	57	0.60	1.08	0.0044	6.90
Health centers established	231	0.0050	0.0136	0.0000	0.1045
Conditional on > 0	127	0.0090	0.0174	0.0002	0.1045
Child health and prenatal conferences	231	0.37	0.81	0.0000	6.22
Conditional on > 0	200	0.42	0.85	0.0012	6.22
Prenatal letters distributed	231	1.94	21.74	0.0000	330.26
Conditional on > 0	85	5.28	35.72	0.0058	330.26
Expenditure Data ($ per 1,000 in population)					
Sheppard-Towner grant accepted	231	12.14	11.49	0.00	92.95
Conditional on > 0	206	13.62	11.31	0.76	92.95
Outlays on the conservation of child life	231	30.44	27.11	2.17	180.14
Outlays on health and sanitation	231	304.70	188.52	81.83	1,092.49

Notes: Annual population estimates used to calculate per capita figures are constructed by linearly interpolating between the census years of 1920 and 1930.

Sources: Infant mortality rates are from Linder and Grove (1947). Sheppard-Towner activities and accepted grant amounts come from U.S. Children's Bureau (1925, 1926a, 1927a, 1928, 1929, 1931); outlay data taken from U.S. Bureau of the Census (1925–1930).

[a] Data for nonwhites exclude observations from New Hampshire and Vermont. The nonwhite populations in those states during the sample period were very small, and the nonwhite infant mortality rates are reported as zero for some years.

Table 2 State-level regression models for overall infant mortality rates, 1924–1929

	Separate Regressions by Public Health Measure		Combined Regression	
	Coefficients (1)	Elasticities (2)	Coefficients (3)	Elasticities (4)
Sheppard-Towner Grant Accepted	0.2377	0.0460		
	(0.2042)	(0.0393)		
Outlays on the Conservation of Child Life	–0.0922†	–0.0401†	–0.0721*	–0.0317*
	(0.0483)	(0.0210)	(0.0295)	(0.0130)
Outlays on Health and Sanitation	–0.0206*	–0.0896*	–0.0212†	–0.0934†
	(0.0084)	(0.0364)	(0.0121)	(0.0531)
Home Nurse Visits	–0.0793**	–0.0144**	–0.0813**	–0.0148**
	(0.0111)	(0.0020)	(0.0192)	(0.0035)
Midwives Enrolled in Classes	0.3983	0.0034	0.3764	0.0033
	(0.7974)	(0.0068)	(0.9695)	(0.0084)
Health Centers Established	–129.5825**	–0.0168**	–113.0442*	–0.0147*
	(41.5531)	(0.0054)	(45.0550)	(0.0059)
Child Health and Prenatal Conferences	–0.8724	–0.0052	0.8729	0.0053
	(2.1105)	(0.0127)	(0.8626)	(0.0052)
Prenatal Letters Distributed	–0.0059†	–0.0004†	–0.0058†	–0.0004†
	(0.0031)	(0.0002)	(0.0032)	(0.0002)
Number of States	46		46	
Number of State-Year Observations	231		231	

Notes: Standard errors are in parentheses. The dependent variable for all models is the overall infant mortality rate. Independent variables are all scaled to be per 1,000 persons in the population. All models include state fixed effects, state-specific linear time trends, and year fixed effects. Elasticities are calculated at the means of the independent variables conditioned on being nonzero values. Standard errors are calculated to allow for clustering by state.

†$p \le .10$; *$p \le .05$; **$p \le .01$

elasticities from eight separate regressions, each including only one measure of public health activity; the third and fourth columns show the results from a single regression that includes all the activity measures and the two expenditure measures as explanatory variables. The elasticities are calculated at the means of the public health measures, conditioned on being positive values. All models include state fixed effects, year fixed effects, and state-specific time trends.

The first three rows of Table 2 describe the effect of the financial variables on infant mortality. The Sheppard-Towner accepted grant amount per capita has no statistically significant impact on infant mortality rates during the period, and in fact, the estimated coefficient on this variable is positive. Based on this result alone, one would have to argue that Sheppard-Towner had no beneficial effect on infant mortality. However, as discussed previously, the amount a state accepted from the federal government may be a poor measure of its efforts to improve infant and child health during the period. Although states had to match federal funds above the initial $5,000 grant, some states may have already had expenditures that exceeded the match amount.

Both state spending on "child life" per 1,000 population and overall state spending on health and sanitation (also per 1,000) reduced infant mortality. Although the elasticity of health and sanitation expenditures is about twice the size of the elasticity of child life expenditures, this difference reflects the much different scales of the two expenditure measures rather than the relative effectiveness in reducing infant deaths. The estimates indicate that one dollar (per 1,000 in the population) spent on child life activities reduced infant mortality by 0.09 per 1,000 births, compared with only 0.02 for one dollar spent on health and sanitation expenditures. Another way of describing this finding is to say that to avert one death, expenditures per 1,000 population on child life activities had to increase by about $11, whereas overall health and sanitation expenditures would have to increase by about $49 per 1,000 population. These results seem at odds with those of Fox (2011), who found that public health expenditures by cities during this period have no effect on mortality rates in models allowing for city time trends. This contrast may reflect the fact that many of the state-level public health initiatives during this period—and particularly Sheppard-Towner programs—were targeted at rural areas.

Finding that greater expenditures on child life programs, and health and sanitation more generally, reduced infant deaths suggests that the public health initiatives of the period had beneficial effects. Yet, we are still left with the question of what specific activities generated these effects. Many different types of activities fall within the "child life" activity category. We want to know whether some of these activities were more effective than others.

We report results (all per 1,000 population) for nurse visits to homes, the number of child health conferences conducted, the number of midwives enrolled in classes, the number of public health centers established, and the number of prenatal letters distributed. These are the most common activities for which states used Sheppard-Towner funds, and they are consistently reported for the years 1924–1929. The estimated coefficients on the numbers of home nurse visits, health centers established, and prenatal letters distributed are statistically significant and indicate meaningful reductions in the overall rate of infant mortality. Looking at the magnitudes of the estimated coefficients, Table 2 shows that a 1 standard deviation increase in the number of home nurse visits reduces infant mortality by about 1.8 deaths per 1,000 live births (a decrease of about 2.6 % when calculated at the mean of the dependent variable). A 1 standard deviation increase in the number of health centers lowers infant mortality by 2.25 deaths, and a 1 standard deviation increase in the number of prenatal letters distributed (an increase of 36 letters per 1,000 population) reduces infant mortality by about 0.2 deaths per 1,000 live births. These results hold even when all the measures are included in the same regression model (columns 3 and 4).

The estimates in Table 2 suggest that it was the more direct and personal interventions that were effective in reducing infant mortality during the period. Providing child health and prenatal clinics increased access to medical care and instruction. Likewise, sending nurses to visit the homes of new mothers likely had a greater impact on the care of infants in an area than could be achieved by holding a child health conference and inviting new mothers to attend.[15] By all accounts, the prenatal and child health conferences were well attended. Building on the experiences during the "Children's Year," many states made them the centerpiece of their maternal and infant health

[15] We also cannot discount the possibility of selection bias; mothers who were more aware of the value of hygiene may have been more likely than other mothers to attend child health conferences.

programs. However, even at the time, some in the public health community questioned their effectiveness. The staff at the conferences had limited contact with mothers and their children and could not always assess the health challenges they faced. There was also no way to ensure that conference attendees received the follow-up care recommended. In the 1930s, the Wisconsin Bureau of Maternal and Child Health (MCH) decided to conduct conferences only in counties where there were county nurses who could follow up with families. Rural physicians, the MCH found, were often not interested in providing preventive care, and some poor families could not even afford emergency care (Apple 2011:175).

Perhaps the most surprising result is the effect of prenatal letters, but these interventions too were more personal than health conferences. These letters provided basic information about prenatal care and cost little to distribute. Similarly, they enabled pregnant mothers to gain access to this information at very low cost, which may help to explain their effectiveness.[16]

Table 3 reports the results of estimating Eq. (1) separately by race. Panels A and B report results for whites and nonwhites, respectively. The story that emerges is that public health interventions had different effects on nonwhite and white infant mortality. Spending on both child life and health/sanitation reduced infant mortality for whites but did not have statistically significant effects on the nonwhite infant mortality rate. For whites, a 1 standard deviation increase in child life spending reduces infant mortality by 1.5 deaths per 1,000 births, while a 1 standard deviation increase in spending on health and sanitation reduces infant mortality by 3.8 deaths. Strikingly, the Sheppard-Towner grant amount accepted per capita has a *positive* and statistically significant effect on nonwhite infant mortality. This may reflect the fact that states with higher infant mortality rates may have been more likely to seek out Sheppard-Towner funding, thus imparting a positive bias to the estimated coefficient. In the most saturated specification, this kind of endogeneity should occur only if we believe that states reacted to deviations in their long-run trends. Although this seems unlikely, we cannot rule it out.[17]

While the results suggest that nonwhites did not benefit from public health spending overall, the data in Table 3 do indicate that nonwhites benefited from certain types of Sheppard-Towner activities. Again, classes for midwives and child health conferences appear to have no beneficial impact on either whites or nonwhites. The variable measuring public health nurse visits per 1,000 population is statistically significant for whites but is only marginally statistically significant for nonwhites (p value of .106). Nevertheless, the estimated coefficient is much larger in magnitude for nonwhites. A 1 standard deviation increase in nurse visits per 1,000 population reduces nonwhite infant mortality by 8.7 deaths per 1,000 births (a decrease of about 6.8 % when calculated at the mean of nonwhite infant mortality). For whites, the same increase generates a decrease in infant mortality by 1.2 deaths, or 1.7 %. We find similar results when looking at the impact of a 1 standard deviation increase in the number of health centers established per 1,000 population. For whites, this increase reduces infant mortality by 1.9 deaths, but the same increase reduces nonwhite infant mortality by 8.4 deaths per

[16] In results not presented, we found that the impact of prenatal letters was most pronounced in states with larger rural populations, suggesting that women with limited access to medical care benefited most from this type of intervention.

[17] If such a bias exists, it would mean our estimates of the effects of Sheppard-Towner activities are understated.

Table 3 State-level regression models for infant mortality rates by race, 1924–1929

	Separate Regressions by Public Health Measure		Combined Regression	
	Coefficients (1)	Elasticities (2)	Coefficients (3)	Elasticities (4)
Panel A: Whites				
Sheppard-Towner grant accepted	0.1487	0.0307		
	(0.1848)	(0.0381)		
Outlays on the conservation of child life	–0.0539†	–0.0250†	–0.0472*	–0.0221*
	(0.0317)	(0.0147)	(0.0190)	(0.0089)
Outlays on health and sanitation	–0.0202*	–0.0936**	–0.0203†	–0.0953†
	(0.0077)	(0.0357)	(0.0108)	(0.0507)
Home nurse visits	–0.0535**	–0.0103**	–0.0758**	–0.0147**
	(0.0117)	(0.0023)	(0.0189)	(0.0037)
Midwives enrolled in classes	0.2915	0.0027	0.2080	0.0019
	(0.9917)	(0.0090)	(1.1177)	(0.0103)
Health centers established	–106.3994†	–0.0147†	–91.2937	–0.0126
	(54.6157)	(0.0076)	(60.1847)	(0.0084)
Child health and prenatal conferences	0.6372	0.0041	2.1352*	0.0138**
	(1.5350)	(0.0098)	(0.8013)	(0.0052)
Prenatal letters distributed	–0.0072*	–0.0006*	–0.0064*	–0.0005*
	(0.0028)	(0.0002)	(0.0031)	(0.0003)
Number of states	46		46	
Number of state-year observations	231		231	
Panel B: Nonwhites				
Sheppard-Towner grant accepted	2.8709**	0.2922**		
	(0.9547)	(0.0932)		
Outlays on the conservation of child life	–0.5083	–0.1210	–0.2805	–0.0726
	(0.4025)	(0.0962)	(0.4352)	(0.1100)
Outlays on health and sanitation	0.0225	0.0533	0.0263	0.0682
	(0.0907)	(0.2143)	(0.0868)	(0.2260)
Home nurse visits	–0.3820	–0.0382	–0.2250	–0.0241
	(0.2317)	(0.0236)	(0.2719)	(0.0304)
Midwives enrolled in classes	0.9505	0.0044	1.2003	0.0061
	(2.3294)	(0.0108)	(2.0373)	(0.0104)
Health centers established	–481.6074*	–0.0343*	–469.8142†	–0.0359†
	(239.2452)	(0.0173)	(270.7977)	(0.0216)
Child health and prenatal conferences	–13.0057	–0.0428	–8.3336	–0.0297
	(8.8946)	(0.0294)	(6.0999)	(0.0227)
Prenatal letters distributed	–1.1595	–0.0499	–1.6296	–0.0731
	(1.8158)	(0.0816)	(1.6960)	(0.0816)
Number of states	44		44	
Number of state-year observations	219		219	

Notes: Standard errors are in parentheses. Independent variables are all scaled to be per 1,000 persons in the population. All models include state fixed effects, state-specific linear time trends, and year fixed effects. Elasticities are calculated at the means of the independent variables conditioned on being nonzero values. Standard errors are calculated to allow for clustering by state.

†$p \leq .10$; *$p \leq .05$; **$p \leq .01$

1,000 live births. A 1 standard deviation increase in the distribution of prenatal letters reduces white infant mortality by 0.3 deaths per 1,000 live births but has no statistically significant effect on nonwhite infant mortality rates.

Nonwhite infant mortality appears to have been more responsive than white infant mortality to nurse home visits and the establishment of public health clinics. To the extent that even rural whites may have been better educated about hygiene than blacks, this makes sense. In addition, since blacks had lower literacy rates than whites, the fact that distributing pamphlets about prenatal care did not lower black infant mortality is not surprising. Overall, the results do not provide support for the idea that Sheppard-Towner resources were used to discriminate against blacks, although the results do suggest that increases in broader categories of state spending (child life and health/sanitation) did not reduce nonwhite infant mortality rates. We can only speculate as to the mechanism underlying these differences. One possible explanation is that blacks were much less likely than whites to have access to quality health care initially and thus reaped greater benefits when they finally met with physicians and nurses (Almond et al. 2006; Smith 1999; Thomasson and Treber 2008). Alternatively, the results are also consistent with a Troesken-type explanation that public health workers tried to mitigate ill health among blacks in order to reduce transmission of negative externalities to whites.

Discussion

When the Sheppard-Towner Act was repealed in 1929, the U.S. Children's Bureau strongly asserted that the act was responsible for the decline in infant mortality during the 1920s. Between the inception of Sheppard-Towner in 1922 and its repeal in 1929, the overall infant mortality rate fell from 76.2 to 67.6 deaths per 1,000 live births. To get a sense of the magnitude of the total effect of Sheppard-Towner activities, we use the results reported in column 3 in Tables 2 and 3 to calculate counterfactual infant mortality rates by setting all Sheppard-Towner activity measures to zero. We calculate lower- and upper-bound estimates. Our lower-bound estimates set the outlays on conservation of child life programs and health and sanitation to their sample means. We view these as lower-bound estimates because they assume that Sheppard-Towner grants did not affect a state's expenditures on child health or other public health programs. In contrast, Moehling and Thomasson (2012:95–96) found that per capita expenditures on child life increased approximately one for one with the per capita level of the Sheppard-Towner grant a state received. Therefore, our upper-bound estimates of the impact of the Sheppard-Towner program on infant mortality reduce outlays on child life programs and health and sanitation by the sample mean of the Sheppard-Towner grant accepted.

Our estimates indicate that the overall mortality rate would have been between 0.7 and 1.9 deaths per 1,000 births higher in the absence of any Sheppard-Towner activities, suggesting that Sheppard-Towner explains between 9 % and 21 % of the decline. This aggregate effect, however, is driven primarily by the experiences of nonwhites. Without Sheppard-Towner activities, the white infant mortality rate would have been 0.15 to 1.0 deaths higher, whereas the nonwhite rate would have been 9.9 to 13 deaths higher. While the nonwhite model is estimated with less precision—so the error bounds around this prediction are much wider than for whites—the large difference by race is striking. Blacks do not seem to have been excluded from these programs and, in fact, benefited more than did whites.

Our findings suggest that the Children's Bureau was a bit too optimistic about the contribution of its programs to the decline in infant mortality. Much of the decline in infant mortality in this period seems to be best explained by a continuation of the trend that began at the turn of the century and was driven by improvements in nutrition, water supplies, and sanitation. Nonetheless, our results show that a number of the activities in which states engaged using Sheppard-Towner funds reduced infant deaths. They also point to which activities generated the most impact, knowledge that policymakers could use to guide modern interventions targeted at reducing infant mortality. Specifically, interventions that were less personal and did not provide a means to follow up with women and children had little impact for both blacks and whites. Itinerant health conferences, where physicians and nurses gave lectures and examined children only once and without means for follow-up care, did not reduce infant deaths. On the other hand, both health centers that provided women and children with an ongoing source of care and home visits from public health nurses did reduce infant mortality, particularly among blacks. Providing educational literature that women could keep in their homes also reduced infant mortality, but not among black women, who were less literate.

Further, our counterfactual calculations do not take into account any cumulative effect of the educational programs provided by Sheppard-Towner. The knowledge a woman gained from a home nurse visit after the birth of her first child likely improved the health of her subsequent children as well. Moreover, to the extent that mothers armed with new information passed this information onto their children, subsequent generations also benefited from Sheppard-Towner.

Unfortunately, we do not have good data on how much these specific interventions cost, so we cannot systematically calculate cost-benefit ratios. We can, however, make some speculative calculations based on the pieces of data that are available. For instance, Ohio paid its five public health nurses $9,000 each in 1927. Assuming that the state spent $45,000 annually on public health nursing, the 19,146 visits by public health nurses that year would have cost $2.35 per visit on average (Ohio Director of Finance 1927:88). Our findings suggest that increasing nurse visits by 1 standard deviation (or 23 per 1,000 population) reduced infant mortality overall by 1.8 deaths per 1,000 births. Given the population and fertility rate of Ohio in 1927, this would mean that an additional infant could have been saved for about $1,600 (about $20,400 in 2010 dollars).

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