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WAS THE FIRST PUBLIC HEALTH CAMPAIGN SUCCESSFUL? THE TUBERCULOSIS MOVEMENT AND ITS EFFECT ON MORTALITY

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Abstract

The U.S. tuberculosis movement pioneered many of the strategies of modern public health campaigns. Dedicated to eradicating a specific disease, it was spearheaded by voluntary associations and supported by the sale of Christmas seals. Although remarkable in its scope and intensity, the effectiveness of the tuberculosis (TB) movement has not been studied in a systematic fashion. Using newly digitized mortality data at the municipal level for the period 1900-1917, we explore the effectiveness of the measures championed by the TB movement. Our results suggest that the adoption of a municipal reporting requirement was associated with a 6 percent decrease in pulmonary TB mortality, while the opening of a state-run sanatorium was associated with an almost 4 percent decrease in pulmonary TB mortality. However, these and other anti-TB measures can explain, at most, only a small portion of the overall decline in pulmonary TB mortality observed during the period under study.

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1. INTRODUCTION

In 1900, 194 out of every 100,000 Americans died of tuberculosis (TB), making it the second-leading cause of death, behind only pneumonia/influenza (Jones et al. 2012). Although an effective treatment would not be introduced until after World War II (Daniel 2006), the TB mortality rate fell dramatically over the next three decades. By 1920, it had fallen to 113 per 100,000 persons; by 1930, it had fallen to 71 per 100,000 persons (Jones et al. 2012).

How was TB vanquished, or at least controlled, in the United States and other developed countries? Scholars have proposed several explanations, including better living conditions, herd immunity due to natural selection, reduced virulence, and improved nutrition (Smith 2003; Daniel 2006; Kunitz 2007, pp. 196-197; Lönnroth et al. 2009; Mercer 2014, pp. 127-129). The introduction of basic public health measures (e.g., isolating patients in sanatoriums and TB hospitals) is another potential explanation (Wilson 1990; Fairchild and Oppenheimer 1998), but scholars have questioned whether such measures contributed meaningfully to the decline in TB mortality (McKeown 1976; Coker 2003; Daniel 2006).[1]

Drawing on newly digitized data from a variety of primary sources, the current study explores whether the TB movement contributed to the decline in TB mortality in the United States. The movement began with the establishment of the Pennsylvania Society for the Prevention of Tuberculosis in 1892 and gained momentum when the National Association for the Study and Prevention of Tuberculosis (NASPT) was founded in 1904 (Shryock 1957, p. 52; Teller 1988, p. 30). Spearheaded by voluntary associations composed of both laypersons and physicians and supported

[1] See also Tomes (1989), Bates (1989; 1992), Vynnycky and Fine (1999), and Wilson (2005). Bates (1989, p. 349) wrote that, "in the absence of controlled studies", we may never know "whether or to what degree the tuberculosis movement contributed to the declining death rate in the United States or improved the health of tuberculosis patients." Tomes (1989, p. 477), although also skeptical, argued that "[h]istorians may fairly question the wisdom of spending money on sanatoria instead of on housing subsidies, but they cannot conclusively prove that the tuberculosis movement as a whole played no role in the 'retreat' of the disease."

by the sale of Christmas seals, the U.S. TB movement pioneered many of the strategies of modern public health campaigns (Teller 1988 p. 1 and pp. 121-126; Jones and Greene 2013; Rosen 2015, pp. 226-231).

Between 1900 and 1917, hundreds of state and local TB associations sprung up across the United States (NASPT 1916; Knopf 1922). These associations distributed educational materials and provided financial support to sanatoriums and TB hospitals, where patients with active TB were isolated from the general population and, if lucky, could recover. In addition, these associations advocated, often successfully, for the passage of legislation designed to curb the transmission of TB, including requirements that doctors notify local public health officials about active TB cases.

Reporting requirements were a key feature of the campaign against TB (Knopf 1922, p. 149; Teller 1988, p. 22; Rothman 1995, p. 187). These requirements prevented physicians from concealing a diagnosis of TB from their patients and allowed local health officials to monitor TB patients, ensuring that they were taking precautions not to infect others (Teller 1988, p. 22). In several states, "careless consumptives" could be forcibly committed to TB hospitals or sanatoriums, where they were not a threat to the health of their family and co-workers (Teller 1988, pp. 93-94; Roberts 2009, p. 186). When a TB patient died, municipalities and states often required that his or her premises be thoroughly disinfected.

Although remarkable in its scope and intensity, the effectiveness of the U.S. TB movement has, to date, not been studied in a systematic fashion.[2] Using municipal-level data for the period

[2] Two recent working papers by economists have examined the effects of specific anti-TB public health measures undertaken before an effective treatment for TB was available. Hollingsworth (2014) estimated the relationship between sanatoriums and pulmonary TB mortality using data from North Carolina for the period 1932-1940. He found that an additional sanatorium bed reduced the pulmonary TB mortality rate among whites by .695 per 100,000 population, but had no effect on the black TB mortality rate. Hansen et al. (2017) estimated the relationship between TB dispensaries and TB mortality at the municipal level using data from Denmark for the period 1890-1939. These authors found that the opening of a TB dispensary was associated with a 16 percent reduction in the TB mortality rate, an effect they attributed to dispensaries "facilitating a local diffusion of (hygiene) knowledge about the disease." Hansen et al. (2017) also found that the opening of a sanatorium was associated with a (statistically insignificant) increase in the local TB mortality rate, but noted that, because Denmark is not a large country, TB patients "had the liberty of choosing the

1900-1917 from *Mortality Statistics*, which was published on an annual basis by the U.S. Census Bureau, we estimate the relationship between pulmonary TB mortality and the introduction of public health measures designed to curb the spread of the disease. Such measures included the establishment of sanatoriums, TB hospitals and open-air camps, prohibitions on spitting and the use of common drinking cups, requirements that local health officials be notified about TB cases, and requirements that the premises of deceased TB patients be disinfected.

Our estimates, which control flexibly for common shocks and municipal-level heterogeneity, suggest that most anti-TB measures had no discernable impact on pulmonary TB mortality. Two exceptions to this general result stand out: requiring TB cases to be reported to local health officials is associated with a 6 percent reduction in pulmonary TB mortality, and the opening of a state-run sanatorium is associated with an almost 4 percent reduction in pulmonary TB mortality. These estimated effects are robust across a variety of specifications, but can explain, at most, only a small portion of the overall decline in pulmonary TB mortality observed during the period 1900-1917.

2. Background

Today, cancer and coronary health disease are the leading causes of death in the United States (National Center for Health Statistics 2016), but, at the turn of the 20th century, most Americans did not expect to die from these so-called "modern diseases": influenza, pneumonia, tuberculosis, and gastrointestinal infections took a far greater toll (Jones et al. 2012). The United States experienced a rapid decline in mortality from infectious diseases during the early 1900s (Jones et al. 2012). By 1930, coronary heart disease had become the leading cause of death (Jones et al.

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sanatorium across the country that they liked the most." By contrast, all but the wealthiest TB patients in the United States would have viewed out-of-state sanatoriums as too expensive (Rothman (1995, pp. 207-210). In the United States, state-run and local sanatoriums represented a substantial portion of total capacity (Teller 1988, p. 82), making it much easier to identify their effects on TB mortality.

2012); by 1948, Secretary of State George Marshall declared with confidence that the conquest of all infectious diseases was imminent (Garrett 1994, p. 30).

In an oft-cited review, Cutler et al. (2006) attributed the unprecedented decline in infectious disease mortality experienced in the United States and other Western countries to basic public health measures, including the building of sewage systems, the delivery of clean water, and educational campaigns designed to promote better hygiene. The evidence that sewers and clean water contributed to declines in mortality from diarrhea, dysentery, enteritis, typhoid, and other waterborne diseases is quite strong (Troesken 2001; Cutler and Miller 2005; Ferrie and Troesken 2008; Alsan and Goldin 2015; Beach et al. 2016).[3] However, several prominent scholars have suggested that public health measures did not contribute meaningfully to the decline in TB mortality (McKeown 1976; Coker 2003; Daniel 2006), nor is there particularly convincing evidence that public health measures contributed to the decline in mortality from other important airborne diseases such as influenza, scarlet fever, and whooping cough (Condran and Crimmins-Gardner 1978; Condran and Cheney 1982; Swedlund and Donta 2002; Bootsma and Ferguson 2007).

Gaining a better understanding of the factors that contributed to the control of infectious diseases in the United States could help in the design and implementation of public health interventions in the developing world, where TB remains widespread (World Health Organization 2015; Houben and Dodds 2016). Although most TB infections can be successfully treated with antimicrobial drugs, the World Health Organization estimates that 3.3 percent of new TB cases are multidrug-resistant (WHO 2015, p. 4). The recommended treatment for drug-susceptible TB lasts 6 months, but treatment for multidrug-resistant TB takes 20 months, requires more toxic drugs, and

[3] Relatedly, Clay et al. (2014) found that waterborne lead exposure was associated with higher rates of infant mortality at the turn of the 20th century.

has a much lower success rate (Lange et al. 2014; WHO 2015, p. 56).[4] With multidrug-resistant TB infections on the rise (Lange et al. 2014), some experts have suggested that it may be "time to bring back sanatoria" (Dheda and Migliori 2012, p. 773). At a minimum, assessing the effectiveness of basic public health measures, many of which were pioneered by the U.S. TB movement, has taken on a new urgency.

2.1. A brief introduction to tuberculosis

TB can affect bones, the central nervous system, and other organ systems, but it is primarily a pulmonary disease. In 1882, Robert Koch demonstrated that TB is caused by *Mycobacterium tuberculosis*, which can be spread through coughing, sneezing, or spitting, although many turn-of-the-century doctors in the United States still believed that TB was inherited (Teller 1988, p. 23).[5] During the period under study, TB was often referred to as "consumption" and its sufferers were referred to as "consumptives" (Bynum 2012), reflecting the gradual weight loss caused by the disease.

Over 90 percent of TB infections are latent–asymptomatic and non-communicable (Lawn and Zumla 2011, p. 61). However, approximately half of individuals with active pulmonary TB eventually die if they do not receive treatment (Rutledge and Crouch 1919; Thompson 1943; Gideon and Flynn 2011).[6] Symptoms include a chronic cough, fevers, night sweats, and weight loss (Lawn and Zumla 2011, p. 65).

[4] Multidrug-resistant TB is caused by the bacteria adapting to isoniazid and rifampicin, the two most potent anti-TB drugs, making them ineffective (Lange et al. 2014).

[5] See Lawn and Zumla (2011) for more about the history and microbiology of *Mycobacterium tuberculosis*.

[6] For instance, Thompson (1943) examined 406 TB patients diagnosed between 1928 and 1938. One year after their diagnosis, 40 percent had died; two years after diagnosis, almost 60 percent had died. In a review of studies from the pre-chemotherapy era, Tiemersma et al. (2011) concluded that the duration of TB from onset to either cure or death was, on average, 3 years.

At the turn of the 20th century, TB was the second-leading cause of death in the United States (Jones et al. 2012).[7] It was greatly feared, in part because it often affected healthy men and women in the prime of life (Donald 2016; Tomes 2000). Incident rates were highest in the rapidly growing urban areas of the United States, where people lived and worked in close proximity to one another. In rural areas of the United States, the TB mortality rate was roughly half that of large cities such as Boston, New Orleans, New York, San Francisco, and Washington D.C.[8] An effective treatment would not be introduced until after World War II (Daniel 2006), yet the TB mortality rate fell by more than 60 percent from 1900 to 1930 (Jones et al. 2012).[9] Many, if not most, contemporary observers credited the TB movement for this dramatic reduction in TB mortality (Emerson 1922; Bates 1992, pp. 317-318).

3. The Tuberculosis Movement

The TB movement was, in many respects, the first modern public health campaign. Dedicated to eradicating a specific disease, it was spearheaded by voluntary groups, involved laypersons as well as medical professionals, and, beginning in 1908, was almost entirely funded by the sale of Christmas seals (Knopf 1922, pp. 55-66; Shryock 1957, pp. 55-57; Rosen 2015, pp. 226-

[7] TB has a long and reasonably well documented history. Lesions and other tubercular deformities have been found on the mummified remains of ancient Egyptians, and classical Greek and Roman doctors recognized its symptoms (Daniel 2000, p. 29; Daniel 2006, p. 1863; Smith 2003, p. 465). In Homer's *Odyssey*, the poet referenced a "grievous consumption", which took the soul from one's body (Bynum 2012, p. 13). TB mortality rates in Europe soared with the growth of urban centers such as London and Paris, and peaked in the first half of the 19th century (Dubos and Dubos 1952, p. 9 and pp. 185-186; Smith 2003, p. 465).

[8] See the U.S. Bureau of the Census (1908, p. 66) for TB mortality rates in cities with a population of greater than 100,000 and in the rural areas of registration states.

[9] The first vaccine, BCG, was introduced in 1921 (Lawn and Zumla 2011, p. 67). Although vaccination campaigns were undertaken in Europe, no such campaign was launched in the United States (Cutler et al. 2006, p. 103). Today, despite widespread use of the BCG vaccine, TB is still one of the leading causes of mortality in developing nations, with 1.5 million people succumbing to it every year (World Health Organization 2015). It is estimated that approximately one-fourth of the world's population has a latent TB infection (Houben and Dodd 2016).

231).[10] By harnessing the enthusiasm of laypersons, and coupling this enthusiasm with the knowledge and guidance of professionals, the TB movement inspired and directly shaped subsequent public health campaigns in the United States and around the world (Jacobs 1921; Shryock 1957, pp. 55-56 and pp. 179-182; Rosen 2015, pp. 226-231).

Between 1900 and 1917, hundreds of state and local TB associations were established across the United States (NASPT 1911, 1916, 1919). By 1917, the last year for which we have data, the NASPT was raising well over a million dollars per year through the sale of Christmas seals, and every state had its own association (Knopf 1922). TB associations sponsored lectures, mounted exhibits, distributed press releases, and gave out circulars emphasizing the importance of germ awareness and proper hygiene (Teller 1988, pp. 59-61). Men were urged to shave their beards and carry pocket spittoons, women were urged to stop wearing trailing dresses, and children were taught to play outdoors, keep their face, hands, and fingernails clean, and cover their coughs and sneezes.[11]

The goals and aspirations of TB associations went well beyond educating the public. TB associations provided financial support to sanatoriums, TB hospitals, open-air camps, and dispensaries. They also advocated for the passage of legislation designed to curb the spread of TB and worked closely with local and state health officials, who adopted and distributed their

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[10] Even today, the American Lung Association's mission is largely funded by the sale of Christmas seals (see www.christmasseals.org).

[11] For a historical perspective on the hygiene practices promoted by tuberculosis associations see Tomes (1998, pp. 113-134) and Tomes (2000). An exhaustive list of contemporary hygiene-related admonitions is provided by Knopf (1901). For instance, Knopf (1901, pp. 21-22) wrote:

> In factories, stores, railway cars, waiting-rooms…, menageries—in short wherever many people congregate—there should be a sufficient number of cuspidors well kept and regularly cleaned. They should be made of unbreakable material and have wide openings. If such measures are carried out, there will be no excuse for any one to expectorate on the floor and thus endanger the lives of his fellow-men.

Knopf (1901) also urged children "to always play outdoors unless the weather is too stormy" (p. 72), and advised them to "learn to love fresh air", not to "kiss any one on the mouth", and not to "put pencils in your mouth or wet them with your lips" (p. 71).

educational materials.[12] Below, we describe the history and functions of sanatoriums, TB hospitals, open-air camps, and dispensaries. After describing these institutions, we briefly summarize the anti-TB legislation passed during the period under study.[13]

3.1. Sanatoriums

The first sanatoriums in the United States were established at the end of the 19th century (Knopf 1922, p. 10). Typically located in rural areas or the mountains, they provided a place for TB patients to rest, breathe fresh air, and eat nutritious food. Although TB patients admitted to sanatoriums had similar recovery rates as compared to those who went untreated (Bignall 1977; Teller 1988, pp. 89-90; Daniel 2006), medical professionals at the turn of the 20th century, including the leaders of the TB movement, were convinced that sanatoriums could cure pulmonary TB (Wethered 1906; Knopf 1908). In addition to offering the promise of a cure, sanatoriums isolated TB patients from the community at large and taught them how to avoid infecting their family, friends, and coworkers.

In 1900, there were only 34 sanatoriums operating in the United States, with a total capacity of roughly 4,500 beds (Rothman 1995, p. 198). After the NASPT began selling Christmas seals, additional funds became available and the number of sanatoriums grew rapidly. By 1917, there were well over 200 sanatoriums in operation with a total capacity of more than 19,000 beds (NASPT 1916; Teller 1988, p. 82). Some sanatoriums catered to the rich, offering excellent food and a spa-like atmosphere (Bates 1992, p. 195; Rappold 2007). In contrast, conditions at publicly funded sanatoriums could be quite primitive with patients living in tents or lean-tos on the outskirts of

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[12] Teller (1988, p. 46) wrote that "cooperation between public health officials and the voluntary associations was very common", but noted that "some officials resented the interference of the tuberculosis associations or thought their enthusiasm was misplaced."

[13] Knopf (1922), Shryock (1957), and Teller (1988), among others, provide detailed histories of the TB movement.

urban areas. Several publicly funded sanatoriums required patients to perform manual labor as a means of controlling costs.[14]

3.2. TB hospitals

By 1908, a number of prominent public health experts had come to the conclusion that sanatoriums were inadequate to the task at hand (Bloede 1908; Brown 1908; Newsholme 1908). TB patients were observed to recover when provided with nutritious food and an opportunity to rest, only to relapse upon discharge. More resources, they argued, should be devoted towards isolating the most infections patients—those with advanced pulmonary TB (Bloede 1908; Brown 1908; Newsholme 1908; Hutchinson 1911; Flick 1912). Although a handful of hospitals specialized in caring for these patients, beds were in short supply and conditions were generally abysmal (Waters 1912; Teller 1988, p. 92; Abel 2007, p. 42). Working together, local TB associations and municipal governments opened more facilities; by 1917, there were roughly 150 TB hospitals operating in the United States (NASPT 1916; Knopf 1922; Teller 1988, p. 92).[15]

3.3. Open-air camps

Open-air camps (also referred to as day camps), were seen as a low-cost alternative to sanatoriums for ambulatory TB patients (Robbins 1906; Townsand 1909). During the day, patients received care and were taught how to avoid infecting their family, friends, and coworkers. At night, they returned home "to practice the lessons learned" (Townsand 1909, p. 755). The first open-air camp in the United States was established by the Boston Association for the Relief and Control of

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[14] See Klebs (1909), Bignall (1977), Feldberg (1995, pp. 93-94), Rothman (1995, pp. 207-210), Abel (2007, p. 43), and Rappold (2007) for more details on the conditions in sanatoriums.

[15] This count includes both hospitals specializing in the care of TB patients and general hospitals with wards set aside specifically for TB patients.

Tuberculosis in 1905 (Robbins 1906). A decade later, more than 60 open-air camps were operating across the country (NASPT 1916).

3.4. Dispensaries

Dispensaries functioned as diagnostic units, disseminated educational materials to the public, and served as "clearing houses", sending patients to physicians, sanatoriums, or TB hospitals for treatment (Knopf 1911, p. 112; Bynum 2012).[16] Dispensaries also provided medicines such as cod liver oil or opiate-based cough mixtures (Bynum 2012; Fraser and Clark 1912), which offered temporary relief but could not cure TB. The first TB dispensary in the United States was established in 1891 by Philadelphia's Rush Hospital for Consumption and Allied Diseases; by 1917, there were hundreds of dispensaries in operation across the country (NASPT 1919).

3.5. Reporting requirements

Tuberculosis associations advocated forcefully, and often successfully, for the passage of laws designed to prevent the spread of the disease. In particular, reporting requirements were viewed as crucial to the success of the anti-TB campaign (Knopf 1922, p. 149; Teller 1988, p. 22; Rothman 1995, p. 187). Today, TB case-notification policies and practices are well established in developed, Western countries, yet under-notification remains a problem in the developing world (Uplekar et al. forthcoming).[17]

At the turn of the 20th century, it was common for physicians to conceal a TB diagnosis from their patients (Ambler 1903; Cabot 1908; Girdwood 1910). Physicians feared that their

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[16] Dispensary staff made home visits to educate TB patients on disposing of their sputum, using separate utensils, and cleaning their home and laundry (Bynum 2012).

[17] The World Health Organization's End TB Strategy specifically highlights mandatory TB case notification as integral to ending the TB epidemic by 2030 (Uplekar et al. forthcoming).

patients, upon being told that they had an incurable disease, would seek a second opinion or remove themselves to a sanatorium (Fox 1975). By obligating physicians to notify local health officials of active TB cases, reporting requirements were designed to put an end to this practice and facilitate the monitoring and education of TB patients. During the period under study, 27 states and over 100 municipalities adopted reporting requirements (NASPT 1911, 1916). In New Jersey, New York, Minnesota, Virginia, and Wisconsin, so-called "careless consumptives" could be forcibly committed to TB hospitals or sanatoriums (Teller 1988, pp. 93-94; Roberts 2009, p. 186).

3.6. Disinfection laws

Between 1900 and 1917, 15 states and over 150 municipalities adopted disinfection requirements (NASPT 1916). When a living space was left vacant by the death or removal of a TB patient, the attending physician was expected to notify public health officials so that it could be disinfected. Health officers directed the disinfection and, when deemed necessary, the renovation of the premises.[18]

3.7. Spitting bans

Chewing tobacco was popular at the turn of the twentieth century, and spittoons could be found in offices, hotels, and public buildings. Despite the availability of spittoons, contemporary accounts describe sidewalks and even the floors of street cars as covered in spittle (O'Conner 2015). By 1917, there were over 150 municipal bans on spitting (NASPT 1916). There is anecdotal

[18] Knopf (1901, pp. 22-23) provided step-by-step instructions on the "disinfection of the sick-room." See Vallejo, California (1913) and Colorado (1914) for examples of disinfection laws.

evidence, however, that these bans were not particularly well enforced. Despite fines as high as $25 dollars per infraction, very few people were actually arrested for spitting in public (Newton 1910).[19]

3.8. Common drinking cup bans

Common drinking cups, which were located in schools, trains, and next to municipal water pumps, were viewed as yet another important source of TB infection (Sedgwick 1902; Tomes 1998; Sattar 2016). By 1917, 17 states and more than 150 municipalities had banned the use of the common cup (NASPT 1911, 1916). Working with local governments, tuberculosis associations made drinking fountains available in schools and other public buildings, but common cups continued to be popular, especially in small towns and rural areas (Nydegger 1917; Boudreau 1920; Gladden 1921; McGuire 2012).[20]

4. Mortality Data and Empirical Framework

Municipal-level mortality data come from *Mortality Statistics*, published annually by the U.S. Census Bureau. The inaugural issue of *Mortality Statistics* was published in 1900 and contained mortality counts by cause for over 300 municipalities.[21] By 1917, mortality counts for over 500 municipalities were available. Although the Census Bureau continued to publish *Mortality Statistics*

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[19] Enforcement appears to have been stricter in New York City where, according to Newton (1910), health officers had made 2,513 arrests for violations of the anti-spitting ordinance passed in 1896. Although anti-spitting laws are still on the books, enforcement appears to be extremely lax (York 2003; Williams 2015).

[20] Along with drinking fountains, dispensable cups (e.g., the Dixie Cup) eventually replaced the common cup entirely (Lee 2007).

[21] Cause of death was obtained from the death certificate and coded using the *International Classification of Diseases*. When more than one medical condition was listed on the death certificate, cause of death was based on a standardized algorithm (Armstrong et al. 1999). There is evidence that deaths from TB were, with some frequency, attributed to bronchitis, malaria, and/or pneumonia (Cabot 1900, p. 27; Cabot 1912), an issue we address below.

through 1922, we chose to focus on the period 1900-1917 in an effort to avoid potential confounding from the effects of the 1918 influenza epidemic.

In Figure 1, we report the pulmonary TB mortality rate per 100,000 population for the 548 municipalities in our sample by year.[22] The pulmonary TB mortality rate was 173 per 100,000 population in 1900.[23] From 1900 to 1917, it fell by nearly 28 percent, to 125. We begin our exploration of whether the anti-TB measures championed by the TB movement and described in the previous section contributed to this dramatic reduction in pulmonary TB mortality by estimating the following baseline regression:

$$(1) \qquad \ln(\textit{Pulmonary TB Mortality}_{mt}) = \beta_0 + \boldsymbol{X}_{mt}\boldsymbol{\beta}_1 + v_m + w_t + \Theta_m \cdot t + \varepsilon_{mt},$$

where *m* indexes municipalities and *t* indexes years. Our interest is the variables that compose the vector $\boldsymbol{X}_{mt}$, which were constructed using information available in NASPT (1911, 1916, 1919). Specifically, the vector $\boldsymbol{X}_{mt}$ includes separate indicators for whether municipality *m* was served by a sanatorium, TB hospital, or an open-air camp in year *t*. Appendix Table 1 details when the first sanatorium, TB hospital, and open-air camp opened in each of the municipalities in our sample.[24]

The terms v_m and w_t represent municipality and year fixed effects, respectively. The municipality fixed effects control for municipal-level determinants of pulmonary TB mortality that were constant over time. The year fixed effects control for common shocks to pulmonary TB mortality, although it should be noted that there were no national newspapers or commercial radio

[22] On average, each municipality contributed 13.6 observations to the analysis.

[23] By comparison, the U.S. mortality rate from all forms of TB was 222 per 100,000 population (U.S. Bureau of the Census 1908, p. 66).

[24] Note that Appendix Table 1 lists only municipalities for which we have TB mortality data both before *and* after the particular anti-TB measure was established.

broadcasts. Efforts to educate the public about TB and encourage good hygiene were undertaken entirely at the local (e.g., municipal) level until 1908, when the NASPT established a press service that released bulletins to newspapers and wire services (Teller 1988, p. 59).[25] Throughout the period under study, magazines such as *Good Housekeeping*, *Ladies Home Journal*, and *Popular Science Monthly* ran stories promoting "antisepticonsciousness" (McClary 1980; Tomes 2000; 2002). Any effect these publications might have had on TB mortality is captured by the year fixed effects. In addition to the municipality and year fixed effects, we include municipality-specific linear time trends ($\Theta_m \cdot t$) to account for the possibility that pulmonary TB mortality rates evolved at different rates in municipalities that adopted anti-TB measures versus those that did not. Standard errors are corrected for clustering at the state level (Bertrand et al. 2004), although clustering at the municipal level produced almost identical results to those reported below.

After estimating the baseline regression, we augment the vector $\boldsymbol{X}_{mt}$ with an indicator for whether municipality *m* required the reporting of TB cases. By 1917, 91 municipalities in our sample had adopted ordinances requiring that active TB cases be reported to local health officials.[26] We also include an indicator for whether the municipality was located in a state that required the reporting of TB cases, and separate indicators for whether the municipality required the disinfection of premises vacated by TB patients and whether it was located in a state that required disinfection.

Next, we augment the vector $\boldsymbol{X}_{mt}$ with an indicator for whether municipality *m* prohibited spitting in public. We also include separate indicators for whether it prohibited the common cup

[25] Many state and local TB associations established their own press services after 1908 (Teller 1988, p. 59), but before then newspapers regularly covered the parades, exhibits, and Christmas seal campaigns sponsored by these associations (Tomes 2002). The first U.S. commercial radio broadcast occurred on November 2, 1920 (election night) in Pittsburgh. Up until then, radio stations were operated by amateur hobbyists whose target audience was composed of other hobbyists (Sterling and Kittross 2002, pp. 44-48 and p. 66).

[26] We observe mortality data before and after the adoption of a reporting ordinance for 71 of these cities (see Appendix Table 1).

and whether it was located in a state with a common cup ban. Finally, we include separate indicators for whether municipality *m* had a TB association, whether it was located in a state with a TB association, and whether it was served by a TB dispensary.[27] Descriptive statistics and definitions for all of the variables used in the analysis are reported in Table 1.[28] Information on when these anti-TB measures were adopted is available in Appendix Tables 1 and 2.

5. RESULTS

In the first column of Table 2, we report estimates from the baseline model, which focuses on the relationship between pulmonary TB mortality and the institutions explicitly designed to isolate and care for TB patients. While the estimated coefficients of the sanatorium and open-air camp indicators are negative, they are small in magnitude and not statistically distinguishable from zero. The relationship between pulmonary TB mortality and the TB hospital indicator is positive, but also insignificant.

In the second column of Table 2, we report estimates from a regression model that includes the reporting and disinfection indicators on the right-hand side. The adoption of a reporting requirement at the municipal level is associated with a 5.5 percent ($e^{-.057}$ - 1 = -.055) decrease in the pulmonary TB mortality rate, an estimate that is statistically significant at the 5 percent level. By contrast, there is little evidence that state reporting requirements mattered: the estimated coefficient of the state reporting requirement indicator is small and insignificant. Likewise, there is little

[27] Because we have the exact date on when state TB associations began operation, the first year of the state TB indicator is coded as a fraction. Our definition of TB dispensaries also includes clinics where special medical staffs and separate hours were set aside for TB patients (NASPT 1911, 1916, 1919).

[28] Although not shown in Table 1, we also include binary indicators to control for missing information on the municipal-level anti-TB measures. For instance, if a city had a common cup ban but information on when the ban went into place was missing, we coded *Common Cup Ordinance* as equal to zero and included a separate indicator for this missing information. With one exception, each of our municipal-level anti-TB measures has non-missing information for at least 92 percent of the sample. We observe non-missing information for the municipal disinfection ordinances for 73 percent of the sample.

evidence that disinfection requirements at either the municipal or state levels had an effect on pulmonary TB mortality.

In the third column of Table 2, we report estimates from a regression model that includes spitting and common cup bans on the right-hand side; in the fourth column, we report estimates from a regression model that includes the TB association indicators and an indicator for whether there was a dispensary in operation in municipality *m* and year *t*. None of these anti-TB measures appear to have had an appreciable impact on the pulmonary TB mortality rate. The estimated coefficients are, without exception, small in magnitude and measured imprecisely. By contrast, the relationship between municipal reporting requirements and pulmonary TB mortality is negative, significant, and remarkably stable across these specifications.[29]

5.1. A closer look at the role of sanatoriums

Up to this point in the analysis, we have attempted to capture the effect of the sanatorium movement with a simple indicator of whether municipality *m* was served by a sanatorium in year *t*. However, the most populous cities in the United States were typically served by multiple sanatoriums by the end of the period under study. Moreover, private sanatoriums were often

[29] In Appendix Table 3, we report the results of regressing the natural log of pulmonary TB mortality on three separate anti-TB indices. In the first column of Appendix Table 3, we consider an index based on the sum of the state anti-TB measures listed in Table 1; in the second column, we consider an index based on the sum of the municipal anti-TB measures listed in Table 1; in the third column, we consider an index based on the sum of all of the anti-TB measures listed in Table 1. The results provide no evidence of a relationship between pulmonary TB mortality and these alternative measures of the intensity of the anti-TB movement. We also experimented with consolidating the variables on municipal- and state-level reporting requirements, disinfection requirements, common cup bans, and TB associations into four separate indicators. For example, we defined the reporting requirement variable as equal to one if the municipality or the municipality's state required the reporting of TB cases. None of these alternatively defined anti-TB measures were significantly associated with the pulmonary TB mortality rate. Lastly, we explored whether reporting requirements were more effective in municipalities that were served by a sanatorium. We found no evidence that the interaction between *Reporting Ordinance* and *Sanatorium* had an effect on the pulmonary TB mortality rate.

located in rural areas where air pollution, which was intense in industrial cities such as Chicago, Pittsburgh, and St. Louis (Stradling and Thorsheim 1999), would not interfere with recovery.[30]

In the first column of Table 3, we replace the sanatorium indicator with a continuous variable equal to the number of sanatoriums in municipality *m* at time *t*.[31] In 1900, only three municipalities in our sample were served by a sanatorium; by 1910, 37 of the municipalities in our sample were served by at least one sanatorium, 8 had at least two, and 4 had three or more; by 1917, 80 municipalities were served by at least one sanatorium, 13 had at least two, and 6 had three or more.[32]

The estimated coefficient of the continuous sanatorium variable is positive, but not significant at conventional levels. In an effort to rule out reverse causality, we experimented with adding leads of the sanatorium variables to the regression model. There was no evidence that sanatoriums were opened in response to upswings (or downswings) in TB mortality.[33]

In column (2), we replace the sanatorium indicator with the number of sanatorium beds in municipality *m* at time *t*.[34] In our sample, the average sanatorium had a capacity of nearly 100 beds. However, the number of beds varied widely, with some sanatoriums serving fewer than 10 patients and others accommodating over 1,000. While the estimated coefficient on our measure of

[30] Private sanatoriums catered to the affluent, but could be as large as publicly funded sanatoriums. For instance, the Agnes Memorial Sanatorium in Denver, CO accommodated over 150 patients in 1916, while the Sanatorium of the New Bedford Anti-Tuberculosis Association in New Bedford, MA accommodated over 100 patients (NASPT 1916).

[31] We also experimented with using the number of sanatoriums per 100,000 population of municipality *m* in year *t*, but found no evidence that this alternative measure was related to the pulmonary TB mortality rate.

[32] We have pulmonary TB mortality data before and after the opening of a sanatorium for 70 of these cities (see Appendix Table 1).

[33] These results are available upon request. We experimented with including 1-3 leads of the sanatorium indicator as well as including 1-3 leads of the continuous sanatorium measure. The estimated coefficients of these leads were consistently small and statistically insignificant. We found similar results when we experimented with using continuous variables for open-air camps and TB hospitals.

[34] We also experimented with using the number of beds per 100,000 population, but found no evidence that this measure was related to the pulmonary TB mortality rate.

sanatorium capacity is negative in sign, it is small in magnitude and statistically indistinguishable from zero.[35]

In columns (3) and (4), we explore whether the opening of sanatoriums at the state, as opposed to the municipal, level had an effect on pulmonary TB mortality. Specifically, in column (3) we show the results of augmenting the baseline equation with an indicator for whether municipality *m* was located in state with a sanatorium, and in column (4) we include the total number of sanatoriums operating in the state at time *t*. The results suggest that the opening of sanatoriums at the state level did little to curb the spread of pulmonary TB.

Finally, in column (5) of Table 3, we investigate the role of state-run sanatoriums. In 1900, there were no state-run sanatoriums in the country, but by the end of the period under study there were 29 in operation and they represented a substantial portion of total capacity (NASPT 1919).[36] State-run sanatoriums were typically located in rural areas and were considered more desirable than county-run or municipal sanatoriums. Unlike other publicly funded sanatoriums, state-run sanatoriums often charged weekly fees to "keep out the riffraff" and prioritized admitting incipient TB cases over chronic or advanced cases (Rothman 1995, pp. 207-208).[37]

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[35] It should be noted that our sanatorium-bed measure is, because of data limitations, somewhat crude. We only observe sanatorium capacity at the three points in time corresponding to the publications of the NASPT's *Tuberculosis Directory* (1911, 1916, and 1919). For the intervening years, we assume that capacity remained constant.

[36] According to Teller (1988, p. 82), there were 94 public sanatoriums operating in the United States by 1916. A total of 7,501 beds were available in state-run sanatoriums, 1,279 beds were available in federal sanatoriums, and 4,736 beds were available in municipal sanatoriums. By comparison, there were 87 private sanatoriums operating in the United States in 1916, with a total of 3,447 beds, and 42 philanthropic sanatoriums with a total of 2,711 beds (Teller 1988, p. 82). See Appendix Table 2 for information on when each state-run sanatorium opened during the period 1900-1917. We observe mortality data for 277 municipalities before and after the opening of 25 state-run sanatoriums.

[37] Dr. Herbert Clapp, a supervising physician at the Massachusetts state-run sanatorium, described cases that should be refused admission:

> No bedridden patients should be accepted, nor even those who are confined to their rooms. If an applicant is not strong enough to ride some distance to the examining office, it is cause enough for his rejection…No case of acute tuberculosis should be admitted, nor any case with high fever, nor even with a temperature which, after rest in bed with open windows for one or two weeks, does not come down to perhaps 100° (Clapp 1906, pp. 342-343).

The estimated effect of state-run sanatoriums is negative and significant, although relatively small in terms of magnitude. Specifically, the opening of a state-run sanatorium is associated with a 3.7 percent ($e^{-.038} - 1 = -.037$) reduction in the pulmonary TB mortality rate. This effect is explored in greater depth below.

5.2. Extensions and robustness checks

In Table 4, we present estimates of equation (1) augmented with leads and lags of the municipal reporting ordinance. Consistent with the parallel trends assumption, there is little evidence that pulmonary TB mortality increased in the years leading up to the passage of TB reporting requirements. Before Year 0 (the year in which doctors were required to report active TB cases to local health officials), estimates of the relationship between the reporting indicator and pulmonary TB mortality are small and statistically insignificant; after three years, these estimates are consistently negative and statistically significant at conventional levels. Three or more years after being adopted, the reporting ordinance is associated with a 9-12 percent decrease in pulmonary TB mortality.[38]

Previous studies have produced strong evidence that turn-of-the-century efforts to improve water quality led to substantial reductions in mortality from waterborne diseases (Troesken 2001; Cutler and Miller 2005; Ferrie and Troesken 2008; Beach et al. 2016). Moreover, there is evidence, albeit descriptive in nature, that these efforts reduced mortality from non-waterborne diseases, including TB (Sedgwick and MacNutt 1910; McGee, 1920). Although some contemporary researchers suggested that tuberculosis might be transmitted through waste water (Brown et al. 1916;

[38] In Appendix Table 4, we present estimates of equation (1) augmented with leads and lags of the state-run sanatorium indicator. Again, consistent with the parallel trends assumption, there is little evidence that pulmonary TB mortality increased in the years leading up to the opening of the first state-run sanatorium. By contrast, after 3 years it is associated with a 3-5 percent decrease in pulmonary TB mortality, although it should be noted that the estimated coefficient of the *3+ Years After State-Run Sanatorium* indicator is not consistently significant at conventional levels.

Fink et al. 1917), a more likely explanation for what was dubbed the "Mills–Reincke Phenomenon" is that typhoid and other gastronomical diseases weakened the host, increasing his or her susceptibility to infection from *Mycobacterium tuberculosis* (Ferrie and Troesken 2008). Using data from Chicago for the period 1855-1925, Ferrie and Troesken (2008) found that an additional death from typhoid fever was associated with 1-1.5 additional deaths from tuberculosis and pneumonia.

Because municipal chlorination and filtration projects could have been correlated with the adoption of TB reporting requirements, we included the natural log of the mortality rate from typhoid on the right-hand side of the estimation equation as a robustness check (Clay et al. 2014).[39] The results of this exercise are reported in the first column of Table 5. Including the typhoid mortality rate as a proxy for water quality reduces the magnitude of the estimated relationship between municipal reporting requirements and pulmonary TB mortality, but only slightly. Specifically, requiring that TB cases be reported to local health officials is associated with a 5.5 percent decrease in pulmonary TB mortality. Consistent with Ferrie and Troesken (2008), we find a positive and statistically significant relationship between typhoid and TB mortality. A 10 percent increase in the typhoid mortality rate is associated with a .29 percent increase in the pulmonary TB mortality rate.

In column (2) of Table 5, we restrict our attention to municipalities with more than 50,000 residents. With this restriction in place, reporting requirements are associated with a 6.5 percent decrease in pulmonary TB mortality, which is slightly larger than the baseline estimates reported in Table 2. In column (3) of Table 5, we restrict our attention to municipalities with more than 50,000 residents and population densities in the top 50th percentile.[40] Perhaps because overcrowding

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[39] Because it is equal to zero for 622 observations, we added one to the typhoid mortality rate before taking the natural log. Results were similar if instead we dropped these observations. The mean typhoid mortality rate in our sample is 28 deaths per 100,000 population.

[40] Information on population density for the 100 largest cities in 1910 is available from the U.S. Census Bureau at: http://www.census.gov/population/www/documentation/twps0027/tab14.txt.

facilitated the spread of TB (Rothman 1995, pp. 184-185; Schmidt 2008), the estimated effect of reporting ordinances in column (3) is slightly larger than the baseline estimates in Table 2. Likewise, when we restrict the sample to municipalities with 18 years of non-missing data, the adoption of a reporting requirement is associated with a 6.9 percent decrease in the pulmonary TB mortality rate.

Reporting requirements were aimed at reducing the human-to-human transmission of pulmonary TB. In column (5) of Table 5, we test whether they were related to non-pulmonary TB, which was usually caused by contaminated milk (Teller 1988, pp. 67-68).[41] Because the incidence of non-pulmonary TB mortality was much lower than that of pulmonary TB (and was, in fact, equal to zero for 716 municipality-year combinations), we take its quartic root instead of taking its natural log.[42] Reassuringly, requiring that TB cases be reported to local health officials is not associated with decreased mortality from non-pulmonary TB. In fact, the estimated marginal effect, although small relative to the mean of non-pulmonary TB mortality, is positive. By contrast, taking the quartic root of pulmonary TB mortality produces an estimated marginal effect that is similar in magnitude to the original estimate reported in Table 2.

In Table 6, we investigate the robustness of the negative relationship between the opening of a state-run sanatorium and pulmonary TB mortality. Controlling for typhoid mortality reduces the absolute magnitude of this relationship, but the estimated coefficient is still negative and significant at the 5 percent level. Likewise, restricting the sample to municipalities that contributed 18 years of data produces a slightly smaller estimate than that reported in Table 3, but it is still significant at

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[41] In general, the TB movement was focused on eliminating human-to-human transmission of pulmonary TB and all but ignored bovine TB (Teller 1988, p. 69). Although, a handful of states required the tuberculin testing of dairy cows, bovine TB was not effectively controlled until after 1917, when the USDA undertook a campaign to eradicate the disease (Olmstead and Rhode 2004). Throughout the period under study, milk stations in New York and other cities provided clean milk at a reduced price to poor mothers (Meckel 1990, pp. 78-80). In 1909, Chicago became the first municipality to require the pasteurization of milk. By 1921, most large cities in the United States required pasteurization, which protected consumers from bovine TB and other milk-borne diseases such as typhoid (Meckel 1990, p. 89).

[42] This method of dealing with zeros has been used by Thomas et al. (2006), Tarozzi et al. (2014) and Ashraf et al. (2015), among others. The marginal effect of requiring that TB cases be reported to local health officials is in brackets.

conventional levels. Finally, while there is no evidence that state-run sanatoriums affected non-pulmonary TB mortality, their impact appears to have been most pronounced in municipalities with more than 50,000 residents.

6. WAS MORTALITY FROM OTHER AIRBORNE DISEASES AFFECTED?

In Figure 2, we show trends in mortality for influenza/pneumonia and other airborne illnesses, a broad grouping that includes mortality from measles, scarlet fever, whooping cough (i.e., pertussis), and diphtheria/croup. Like pulmonary TB, these diseases are typically transmitted by aerosolized respiratory secretions (for instance, from coughing or sneezing).[43] During the period 1900-1917, mortality from influenza/pneumonia remained relatively stable, while the mortality rate from other airborne illnesses fell from 105.8 to 45.6.

Did the measures championed by the U.S. TB movement affect mortality from influenza/pneumonia and/or other airborne illnesses? Several anti-TB measures could have, in theory, reduced mortality from other diseases transmitted through respiratory secretions. Indeed, the Centers for Disease Control still recommends frequent hand washing and the covering of coughs to prevent the spread of germs, and would presumably frown upon public spitting and the use of common cups. Although the threat of TB has receded and anti-spitting laws are no longer enforced in the United States (York 2003; Williams 2015), authorities in Beijing, London, and Mumbai have justified recent efforts to discourage spitting on public health grounds (Yardley 2007; Pettitt 2015; Sujit and Iyer. 2015).

In the first column of Table 7, we report results from regressing mortality due to influenza and pneumonia on the spitting law and common cup indicators. In addition, we control for whether

[43] During the period under study, there were no effective vaccines or cures for influenza, measles, scarlet fever, or whooping cough (Quinn 1989; Roush and Murphy. 2007; Cowling et al. 2013; Cherry 2015). However, diphtheria could be treated using a horse-derived antitoxin (Wagner et al. 2009).

municipality *m* had a TB association and whether it was located in a state with a TB association. This exercise produces no support for the notion that spitting laws, common cup ordinances, or efforts on the part of TB associations to educate the public and legislate its behavior had an impact on mortality due to influenza and pneumonia. When we include the other anti-TB measures (e.g., the sanatorium and TB hospital indicators) on the right-hand side of the regression, the results are similar. However, we do find some evidence that municipal spitting laws may have led to small reductions in the influenza and pneumonia mortality rate.

Next, we examine the effects of anti-TB measures on mortality from other airborne illnesses (i.e., measles, scarlet fever, whooping cough, and diphtheria/croup). The results provide little support for the notion that the adoption of anti-TB measures contributed to the dramatic reduction in mortality due to these illnesses documented in Figure 2.[44]

7. GAUGING THE OVERALL IMPACT OF THE TB MOVEMENT

We begin this section with an examination of municipal reporting requirements and their contribution to the overall decline in pulmonary TB mortality. As noted above, 91 municipalities in our sample had adopted ordinances requiring that active TB cases be reported to local health officials by 1917; the adoption of such an ordinance is associated with an approximately 6 percent decline in the pulmonary TB mortality rate (Table 2).

To gauge the impact of reporting ordinances, we calculated what the pulmonary TB mortality rate would have been had none of the municipalities in our sample required reporting of active TB cases. Figure 3 shows the predicted pulmonary TB rate for every year *t* (and its 90 percent confidence interval) under this scenario. Predicted pulmonary TB mortality rates are based on the

[44] Because deaths from TB were, with some frequency, attributed to bronchitis, malaria, and/or pneumonia (Cabot 1900, p. 27; Cabot 1912), we experimented with including these diseases in *Other Airborne Illnesses Mortality*. The estimates reported in Table 7 changed very little when using this alternative definition.

regression estimates in column (4) of Table 2. The actual pulmonary TB mortality rate among the municipalities that compose our sample is also provided.

The actual and predicted pulmonary TB mortality rates are not far apart throughout the period under study, suggesting that the ordinances did not contribute substantially to the observed overall decline in pulmonary TB mortality. By 1917, the actual pulmonary TB mortality rate among municipalities in our sample was 125 per 100,000 population, its lowest level during the period under study. Had no municipality adopted a reporting ordinance, we predict that it would have been 128 per 100,000 population. Even using the upper bound of the 90 percent confidence interval, we predict that the pulmonary TB mortality rate would have fallen from 173 to 132 had no reporting ordinances been adopted.

Finally, we use a similar strategy, and the regression estimates in column (4) of Table 2, to gauge the combined contribution of all the anti-TB measures adopted during the period under study (Figure 4). From 1900 to 1917, the pulmonary TB mortality rate among the municipalities in our sample fell by nearly 28 percent, from 173 to 125 per 100,000 population. Had no anti-TB measures been adopted, we predict that the pulmonary TB mortality rate would have been 122 per 100,000 population in 1917. Using the upper bound of the 90 percent confidence interval, we predict that the pulmonary TB mortality rate would have still fallen by 22 percent, to 135.5 per 100,000 population, had no anti-TB measures been implemented at either the municipal or state levels.

8. CONCLUSION

One out of every 4 people alive today has a latent tuberculosis (TB) infection (Houben and Dodds 2016). Most TB infections, if they become active, can be successfully treated with antimicrobial medicines, but the WHO (2015, p. 56) estimates that 3.3 percent of new TB cases are multidrug-resistant.[45] With experts warning that multidrug-resistant strains of TB represent a "looming public health crisis" (Frieden 2015), it is perhaps more important than ever that we accurately assess the effectiveness of basic, "low-tech" public health measures, many of which were pioneered by the TB movement.

The U.S. TB movement can be traced to the establishment of the Pennsylvania Society for the Prevention of Tuberculosis in 1892 (Shryock 1957, p. 52); it gained momentum with the founding of the National Association for the Study and Prevention of Tuberculosis (NASPT) in 1904. Between 1904 and 1917, hundreds of state and local TB associations were established across the country with the goal of educating the public and giving support to sanatoriums, TB hospitals, and open-air camps. TB associations also advocated for the passage of legislation aimed at curbing the spread of TB. Such legislation included public spitting bans and requirements that active TB cases be reported to health officials. Reporting requirements prevented physicians from concealing TB diagnoses and allowed public health officials to monitor TB patients (Teller 1988, p. 22).

Despite the remarkable scope and influence of the TB movement, its effect on TB mortality has not been studied in a systematic fashion. In fact, many historians appear to believe that gauging the impact of the TB movement on TB mortality is impossible. For instance, Bates (1989, p. 349) wrote that, "in the absence of controlled studies," we may never know "whether or to what degree the tuberculosis movement contributed to the declining death rate in the United States or improved the health of tuberculosis patients." Experts from other disciplines have also expressed skepticism regarding the effectiveness of the TB movement (McKeown 1976; Coker 2003; Daniel 2006).

Using newly digitized mortality data at the municipal-year level, we explore the effect of the TB movement on pulmonary TB mortality. We find strong evidence that requiring TB cases to be

[45] Multidrug-resistant TB is caused by the bacteria adapting to the drugs typically used to treat it, making them ineffective. The recommend treatment for drug-susceptible TB lasts six-months, but treatment for multidrug-resistant TB takes 20 months, requires more toxic drugs, and has a much lower success rate (WHO 2015, p. 4).

reported to local health officials led to a 6 percent reduction in the pulmonary TB mortality rate, lending support to the argument that addressing the under-notification problem is critical to the success of anti-TB efforts in developing counties today (Uplekar et al. forthcoming). We also find that the establishment of a state-run sanatorium led to an almost 4 percent reduction in the pulmonary TB mortality rate. By contrast, there is no evidence that other anti-TB measures (for instance, requiring the premises of deceased TB patients to be disinfected or the prohibition of common drinking cups) were effective.

Finally, to gauge the overall effect of the TB movement, we calculated what the pulmonary TB mortality rate would have been had no anti-TB measures been implemented. During the period under study, the pulmonary TB mortality rate among the municipalities in our sample fell by nearly 28 percent, from 173 to 125 per 100,000 population. Had no anti-TB measures been adopted, we predict that the pulmonary TB mortality rate would have been 122 per 100,000 population in 1917. Using the upper bound of the 90 percent confidence interval, we predict that the pulmonary TB mortality rate would have still fallen by 22 percent, to 135.5 per 100,000 population, had the TB movement never occurred. Based on these estimates, we conclude that the basic anti-TB measures employed during the early 1900s did not contribute substantially to the marked decline in the TB mortality rate.

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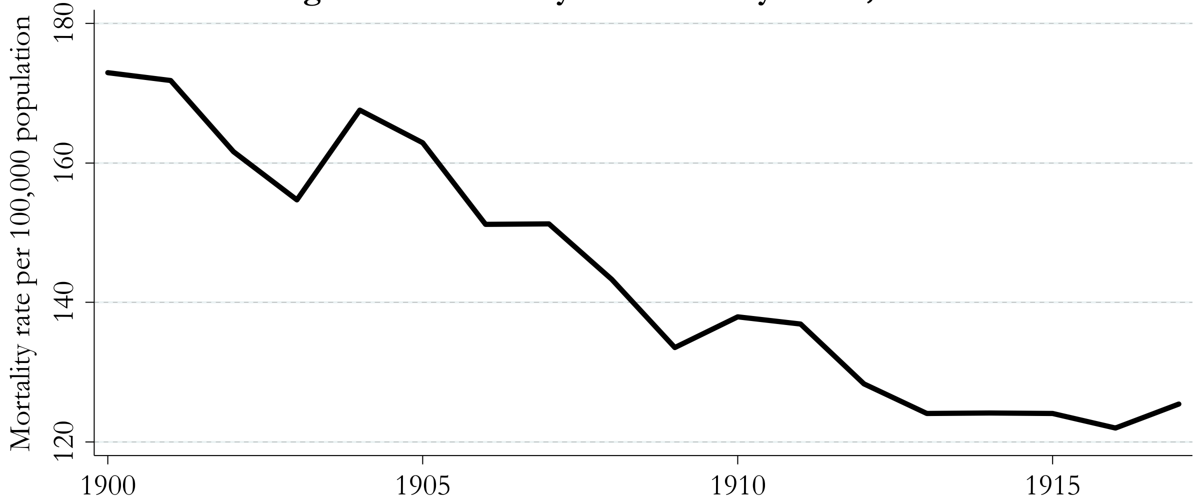
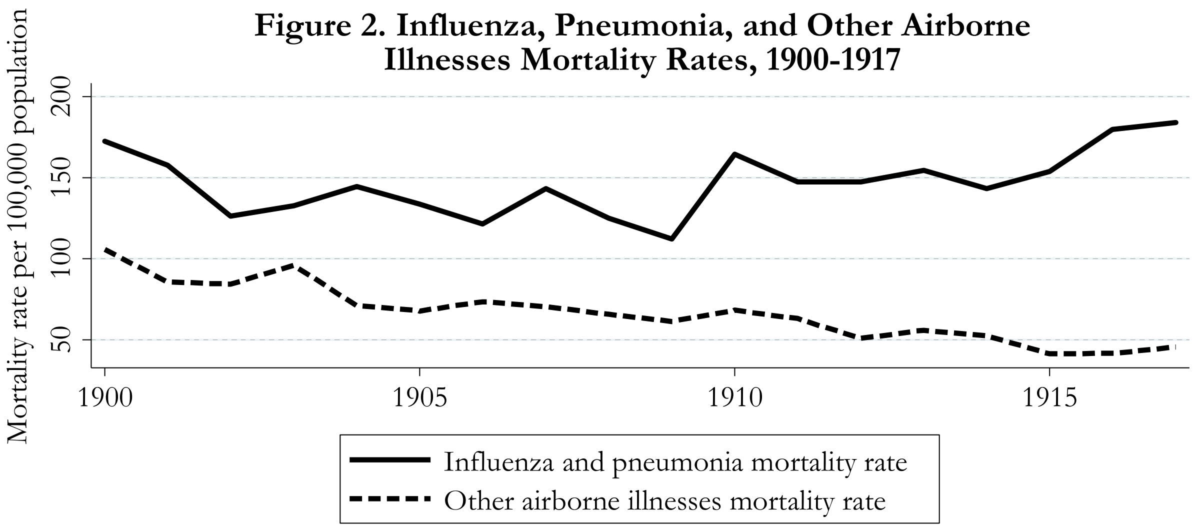
Figure 1. Pulmonary TB Mortality Rates, 1900-1917



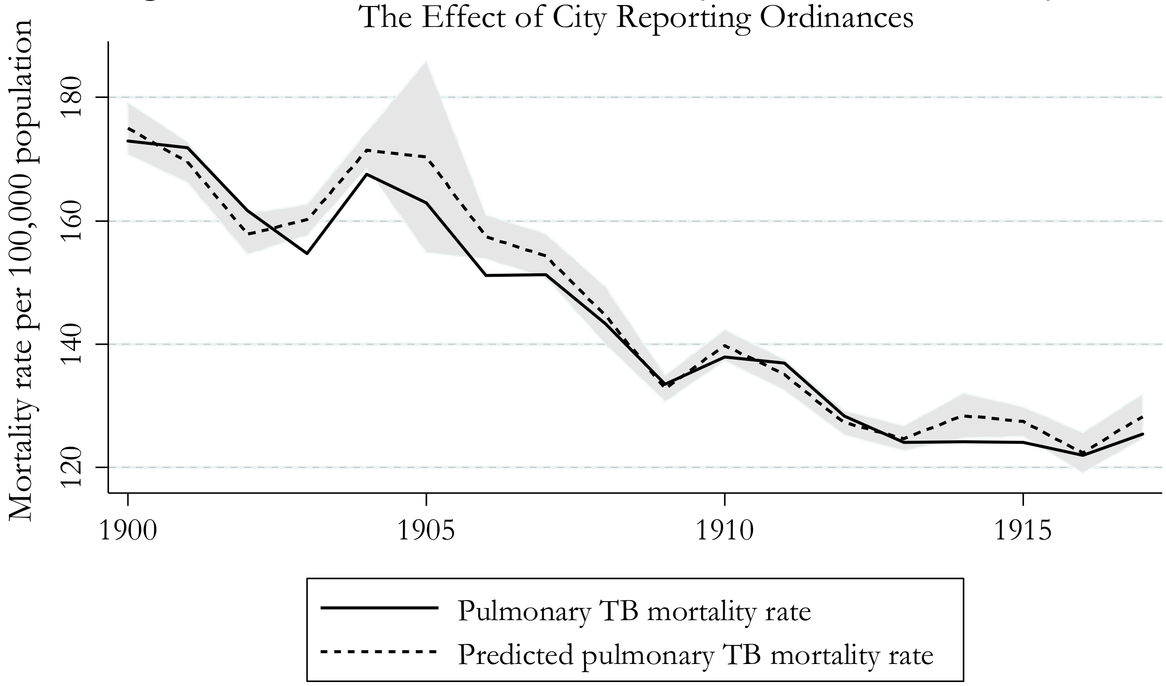
Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau.

Figure 2. Influenza, Pneumonia, and Other Airborne Illnesses Mortality Rates, 1900-1917



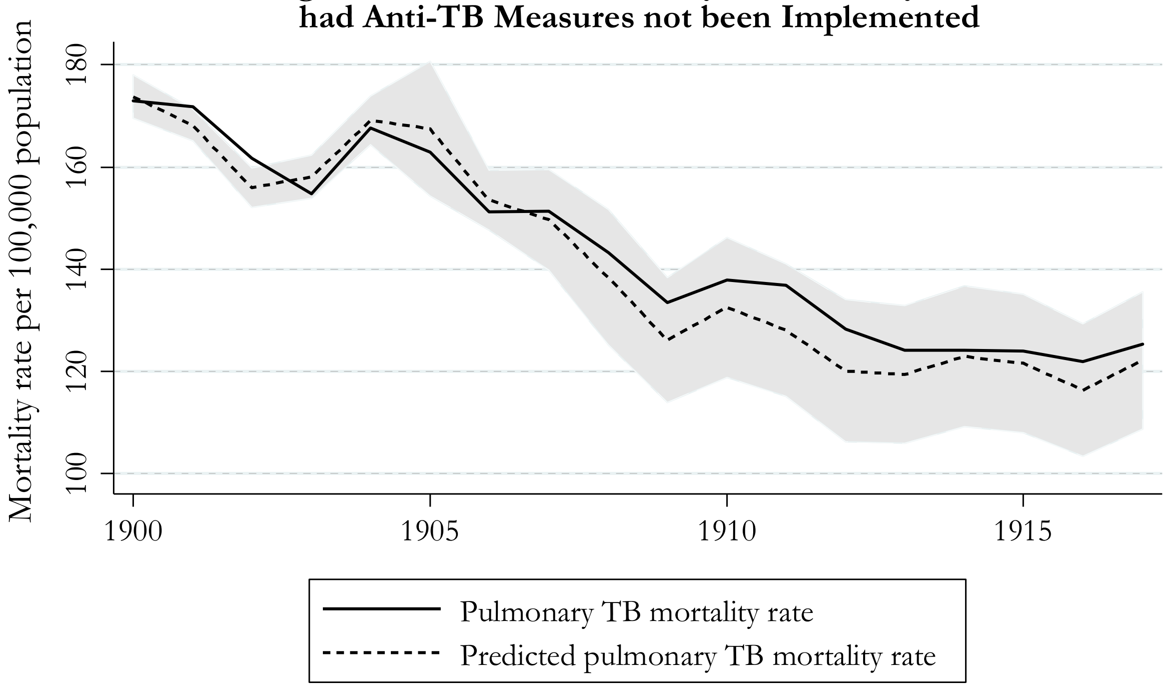
Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Other airborne illnesses include measles, scarlet fever, whooping cough, and diphtheria/croup.

Figure 3. Actual vs. Predicted Pulmonary Tuberculosis Mortality Rates:
The Effect of City Reporting Ordinances



Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Predicted pulmonary TB mortality rates are calculated under the assumption that city reporting ordinances were not implemented. Shaded area represents 90% confidence region around predicted pulmonary TB mortality rates.

Figure 4. Predicted Pulmonary TB Mortality Rates had Anti-TB Measures not been Implemented



Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Predicted pulmonary TB mortality rates are calculated under the assumption that none of the anti-TB measures listed in Table 1 were implemented. Shaded area represents 90% confidence region around predicted pulmonary TB mortality rates.

Table 1. Descriptive Statistics for Pulmonary TB Mortality Analysis, 1900-1917

	Mean (SD)	Description
Pulmonary TB Mortality	141.5 (78.7)	Pulmonary tuberculosis mortality per 100,000 population
Sanatorium	.078 (.268)	= 1 if municipality had a sanatorium, = 0 otherwise
TB Hospital	.087 (.281)	= 1 if municipality had a TB hospital, = 0 otherwise
Open-Air Camp	.068 (.251)	= 1 if municipality had an open-air camp, = 0 otherwise
Reporting Ordinance	.131 (.338)	= 1 if municipality required reporting of TB cases, = 0 otherwise
State Reporting Law	.510 (.500)	= 1 if state required reporting of TB cases, = 0 otherwise
Disinfection Ordinance	.067 (.249)	= 1 if municipality required disinfection of premises after death or removal of a TB patient, = 0 otherwise
State Disinfection Law	.079 (.269)	= 1 if state required disinfection of premises after death or removal of a TB patient, = 0 otherwise
Spitting Ordinance	.273 (.446)	= 1 if municipality had an anti-spitting ordinance, = 0 otherwise
Common Cup Ordinance	.018 (.134)	= 1 if municipality had a common cup drinking ban, = 0 otherwise
State Common Cup Law	.110 (.314)	= 1 if state had a common cup drinking ban, = 0 otherwise
Municipal TB Association	.360 (.480)	= 1 if municipality had a TB association, = 0 otherwise
State TB Association	.697 (.451)	= 1 if state had a TB association, = 0 otherwise
Dispensary	.261 (.439)	= 1 if municipality had a TB dispensary, = 0 otherwise
N	7,439	

Notes: Unweighted means with standard deviations in parentheses.

Table 2. Pulmonary TB Mortality and Anti-TB Interventions, 1900-1917

	(1)	(2)	(3)	(4)
Sanatorium	-.017	-.014	-.016	-.018
	(.026)	(.025)	(.024)	(.024)
TB Hospital	.022	.022	.021	.023
	(.029)	(.028)	(.029)	(.028)
Open-Air Camp	-.021	-.019	-.017	-.015
	(.021)	(.019)	(.022)	(.020)
Reporting Ordinance	…	-.057**	-.061**	-.062**
		(.026)	(.030)	(.028)
State Reporting Law	…	-.008	-.007	-.011
		(.014)	(.015)	(.016)
Disinfection Ordinance	…	.040	.042	.035
		(.030)	(.032)	(.032)
State Disinfection Law	…	-.020	-.024	-.021
		(.025)	(.028)	(.029)
Spitting Ordinance	…	…	.019	.014
			(.026)	(.023)
Common Cup Ordinance	…	…	.010	.014
			(.021)	(.021)
State Common Cup Law	…	…	-.021	-.022
			(.021)	(.022)
Municipal TB Association	…	…	…	.005
				(.016)
State TB Association	…	…	…	.023
				(.020)
Dispensary	…	…	…	.019
				(.019)
N	7,439	7,439	7,439	7,439
R^2	.882	.882	.883	.883

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Controls include municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 3. A Closer Look at Sanatoriums

	(1)	(2)	(3)	(4)	(5)
Sanatorium	…	…	-.014	-.019	-.019
			(.023)	(.024)	(.023)
Number of Sanatoriums in Municipality	.018	…	…	…	…
	(.020)				
Number of Sanatorium Beds in Municipality (100s of beds)	…	-.002	…	…	…
		(.003)			
Any Sanatorium in State	…	…	.002	…	…
			.017		
Number of Sanatoriums in State	…	…	…	-.003	…
				(.005)	
State-Run Sanatorium	…	…	…	…	-.038**
					(.016)
N	7,439	7,439	7,439	7,439	7,439
R^2	.883	.883	.883	.883	.883

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Controls include the covariates listed in Table 1, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 4. Pulmonary TB Mortality and Leads and Lags of Municipal Reporting Ordinances

	(1)	(2)	(3)	(4)
3 Years Prior to Reporting Ordinance	…	…	…	.012
				(.021)
2 Years Prior to Reporting Ordinance	…	…	-.017	-.011
			(.020)	(.027)
1 Year Prior to Reporting Ordinance	…	-.033	-.039	-.034
		(.028)	(.034)	(.042)
Year 0	-.067**	-.078**	-.085*	-.079
	(.031)	(.037)	(.043)	(.051)
1 Year After Reporting Ordinance	-.056**	-.068*	-.075*	-.069
	(.027)	(.034)	(.041)	(.051)
2 Years After Reporting Ordinance	-.060*	-.074*	-.082*	-.075
	(.030)	(.037)	(.043)	(.053)
3+ Years After Reporting Ordinance	-.091**	-.108**	-.117**	-.109*
	(.037)	(.044)	(.051)	(.062)
Mean	141.5	141.5	141.5	141.5
N	7,439	7,439	7,439	7,439
R^2	.883	.883	.883	.883

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Controls include the covariates listed in Table 1, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 5. Extensions and Robustness of Municipal Reporting Ordinances

	(1)	(2)	(3)	(4)	(5)	(6)
	Control for typhoid mortality	Cities with population > 50,000	Densely populated cities with population > 50,000	Cities with 18 years of data	Dependent variable: $(\textit{Non-pulmonary TB Mortality})^{1/4}$	Dependent variable: $(\textit{Pulmonary TB Mortality})^{1/4}$
Reporting Ordinance	-.057**	-.067**	-.075*	-.071**	.019	-.056**
	(.027)	(.031)	(.042)	(.029)	(.021)	(.025)
					[.639]	[-9.11]
ln(*Typhoid Mortality*)	.029**	...	...	...	...	...
	(.012)					
Mean of TB Mortality	141.5	162.0	164.6	143.9	17.6	141.5
N	7,439	1,693	931	5,254	7,439	7,439
R^2	.884	.924	.915	.884	.608	.889

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. Columns (1)-(4): The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Columns (5)-(6): The dependent variable is equal to the quartic root of the specified mortality rate per 100,000 population in municipality *m* and year *t*; marginal effects are in brackets. Controls include the covariates listed in Table 1, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 6. Extensions and Robustness of State-Run Sanatoriums

	(1)	(2)	(3)	(4)	(5)	(6)
	Control for typhoid mortality	Cities with population > 50,000	Densely populated cities with population > 50,000	Cities with 18 years of data	Dependent variable: (*Non-pulmonary TB Mortality*)$^{1/4}$	Dependent variable: (*Pulmonary TB Mortality*)$^{1/4}$
State-Run Sanatorium	-.037**	-.043**	-.044	-.034**	.011	-.032**
	(.014)	(.019)	(.026)	(.015)	(.019)	(.015)
					[.391]	[-5.27]
ln(*Typhoid Mortality*)	.029**	...	...	...	...	...
	(.012)					
Mean of TB Mortality	141.5	162.0	164.6	143.9	17.6	141.5
N	7,439	1,693	931	5,254	7,439	7,439
R^2	.884	.925	.916	.884	.608	.890

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. Columns (1)-(4): The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality m and year t. Columns (5)-(6): The dependent variable is equal to the quartic root of the specified mortality rate per 100,000 population in municipality m and year t; marginal effects are in brackets. Controls include the covariates listed in Table 1, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 7. Did Anti-Spitting Ordinances, Common Cup Bans, or TB Associations have Spillover Effects on other Airborne Illnesses?

	(1)	(2)	(3)	(4)
	Flu and Pneumonia Mortality	*Flu and Pneumonia Mortality*	*Other Airborne Illnesses Mortality*	*Other Airborne Illnesses Mortality*
Spitting Ordinance	-.046	-.050*	-.019	-.017
	(.030)	(.026)	(.043)	(.044)
	[-7.78]	[-8.56]	[-1.49]	[-1.29]
Common Cup Ordinance	.020	.046	-.041	-.016
	(.103)	(.069)	(.033)	(.044)
	[3.41]	[7.76]	[-3.20]	[-1.24]
State Common Cup Law	.060	.064	-.029	-.032
	(.043)	(.039)	(.044)	(.047)
	[10.1]	[10.8]	[-2.23]	[-2.45]
Municipal TB Association	-.021	-.027	.008	.015
	(.025)	(.028)	(.021)	(.023)
	[-3.62]	[-4.64]	[.639]	[1.19]
State TB Association	.004	.011	.053**	.043
	(.039)	(.037)	(.024)	(.026)
	[.743]	[1.83]	[4.12]	[3.34]
Mean of Mortality Rate	148.1	148.1	51.9	51.9
N	7,439	7,439	7,439	7,439
R^2	.739	.743	.567	.568
Other Anti-TB Measures?	No	Yes	No	Yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. Columns (1)-(2): The dependent variable is equal to the quartic root of the influenza and pneumonia mortality rate per 100,000 population in municipality *m* and year *t*; marginal effects are in brackets. Columns (3)-(4): The dependent variable is equal to the quartic root of the measles, scarlet fever, whooping cough, and diphtheria/croup mortality rate per 100,000 population in municipality *m* and year *t*; marginal effects are in brackets. Controls include municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
AL	Birmingham	1908-1917	1910							1910	1911
AL	Mobile	1900-1917									1914
AL	Montgomery	1908-1917			1911				1911		1909
CA	Alameda	1900-1917								1909	
CA	Bakersfield	1910-1917								1917	
CA	Berkeley	1906-1917									1910
CA	Eureka	1910-1917								1911	
CA	Fresno	1900-1917	1915					1911		1914	1916
CA	Los Angeles	1900-1917	1902							1908	1906
CA	Oakland	1900-1917						1903		1909	1910
CA	Pasadena	1906-1917	1909			1912		1910		1909	1915
CA	Sacramento	1900-1917		1916				1904		1908	1915
CA	San Bernardino	1910-1917								1917	
CA	San Diego	1900-1917		1903	1912			1907		1910	1909
CA	San Francisco	1900-1917	1909			1903			1913	1908	1909
CA	San Jose	1900-1917		1911				1907		1909	1911
CA	Stockton	1906-1917			1909					1912	1915
CO	Colorado Springs	1906-1917				1908	1909	1907	1912	1910	
CO	Denver	1900-1917						1905		1917	1913
CO	Pueblo	1900-1917						1905			1910
CT	Bridgeport	1900-1917		1917	1907	1902	1902			1914	
CT	Bristol	1900-1917								1917	1916
CT	Greenwich	1900-1917			1912						
CT	Hartford	1900-1917	1902					1906		1905	1908
CT	Meriden	1900-1917	1910			1910	1910	1903	1910	1907	
CT	Middletown	1900-1917								1909	
CT	New Britain	1900-1917				1905				1908	
CT	New Haven	1900-1917		1916	1910	1905		1901		1902	1907
CT	New London	1900-1917								1912	
CT	Norwalk	1900-1917								1909	1909
CT	Norwich	1900-1917	1913			1905				1912	
CT	Stamford	1900-1917			1910			1910		1910	
CT	Wallingford	1900-1917	1904							1915	
CT	Waterbury	1900-1917								1908	1908
DE	Wilmington	1900-1917				1908		1907		1909	1906
DC	Washington	1900-1917		1908	1908	1908		1903		1902	1905

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
FL	Jacksonville	1900-1917		1913				1908			
FL	Tampa	1915-1917			1916						
GA	Atlanta	1900-1917	1909							1907	1907
GA	Savannah	1900-1917				1909		1904		1909	
IL	Aurora	1900-1917								1911	1917
IL	Chicago	1900-1917	1915	1909	1910	1906	1907	1901	1913	1906	1907
IL	Decatur	1900-1917						1902		1917	
IL	Evanston	1908-1917				1915				1910	
IL	Jacksonville	1900-1917								1905	1912
IL	Ottawa	1900-1909			1904						
IL	Quincy	1900-1917						1914			
IL	Springfield	1900-1917			1913			1907		1910	1911
IN	Anderson	1901-1917								1912	
IN	Elkhart	1901-1917								1913	
IN	Evansville	1900-1917		1910				1902		1904	1908
IN	Fort Wayne	1901-1917						1904		1910	1913
IN	Gary	1910-1917								1913	
IN	Huntington	1901-1917								1912	
IN	Indianapolis	1900-1917			1904		1902			1911	1908
IN	Kokomo	1901-1917								1912	
IN	Lafayette	1900-1917			1915					1908	
IN	Laporte	1910-1917								1914	
IN	Logansport	1901-1917								1912	
IN	Muncie	1900-1917								1909	
IN	New Albany	1901-1917								1912	1915
IN	Peru	1900-1917								1913	
IN	Richmond	1900-1917								1907	
IN	South Bend	1901-1917	1914		1909	1902		1906		1908	1908
IN	Terre Haute	1900-1917								1909	
IA	Sioux City	1900-1905						1905			
KS	Kansas City	1908-1917								1913	
KS	Topeka	1912-1917	1916								
KS	Wichita	1900-1917	1917								
KY	Covington	1900-1917									1912
KY	Frankfort	1911-1917								1912	
KY	Henderson	1911-1917	1917								

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
KY	Lexington	1911-1917	1917								
KY	Louisville	1900-1917	1907					1905		1905	1907
KY	Newport	1900-1917								1916	
KY	Owensboro	1911-1917									1915
KY	Paducah	1900-1917								1910	
LA	New Orleans	1900-1917			1908		1912			1906	1908
ME	Auburn	1906-1917								1910	
ME	Augusta	1900-1917									1913
ME	Bangor	1900-1917			1910					1909	1909
ME	Lewiston	1906-1917						1912		1910	1914
ME	Portland	1900-1917					1909				1910
ME	Waterville	1906-1917								1910	1910
MD	Annapolis	1900-1909								1906	
MD	Baltimore	1900-1917						1905			
MD	Cumberland	1906-1917	1913							1909	1913
MD	Frederick	1900-1917								1907	1911
MD	Hagerstown	1907-1917								1911	
MA	Adams	1900-1917			1910					1908	1915
MA	Attleborough	1900-1917								1911	1915
MA	Beverly	1900-1917								1915	1915
MA	Boston	1900-1917	1904		1909					1903	
MA	Brockton	1900-1917						1904		1904	1909
MA	Brookline	1900-1917		1905	1908			1907		1907	1912
MA	Cambridge	1900-1917					1904			1903	1905
MA	Chelsea	1900-1917						1902		1907	1910
MA	Chicopee	1900-1917									1915
MA	Clinton	1900-1917	1915		1909					1908	1916
MA	Everett	1900-1917				1911		1906	1911	1908	1915
MA	Fall River	1900-1917		1907		1906	1906	1901		1908	1913
MA	Fitchburg	1900-1917		1913						1907	1909
MA	Framingham	1900-1917								1909	1915
MA	Gardner	1900-1917								1908	1909
MA	Gloucester	1900-1917				1909		1909		1914	1915
MA	Haverhill	1900-1917	1913			1906		1902		1907	1908
MA	Holyoke	1900-1917	1912		1908			1903		1907	1915
MA	Lawrence	1900-1917		1910	1908					1907	1910

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
MA	Leominster	1900-1917									1915
MA	Lowell	1900-1917			1906	1903	1913	1903		1915	1915
MA	Lynn	1900-1917		1912	1909	1906	1906	1906		1907	1907
MA	Malden	1900-1917								1907	1908
MA	Medford	1900-1917								1907	1915
MA	Melrose	1900-1917								1909	1915
MA	New Bedford	1900-1917	1908							1906	1909
MA	Newburyport	1900-1917								1909	1909
MA	Newton	1900-1917					1914				
MA	North Adams	1900-1917									1914
MA	Northampton	1900-1917	1914							1907	1915
MA	Peabody	1900-1917									1914
MA	Pittsfield	1900-1917	1906	1913						1905	1908
MA	Plymouth	1900-1917									1916
MA	Quincy	1900-1917			1910					1908	1915
MA	Salem	1900-1917		1907	1908			1908		1907	1908
MA	Somerville	1900-1917				1904		1904		1906	1911
MA	Springfield	1900-1917		1912	1908	1904	1909	1901		1904	1907
MA	Taunton	1900-1917								1908	1915
MA	Wakefield	1900-1917									1915
MA	Waltham	1900-1917		1911				1906		1908	1911
MA	Webster	1900-1917									1915
MA	Westfield	1900-1917	1910								1910
MA	Winthrop	1910-1917									1915
MA	Worcester	1900-1917				1902				1907	1904
MI	Adrian	1906-1917								1911	
MI	Alpena	1906-1917								1908	
MI	Ann Arbor	1900-1917								1909	
MI	Battle Creek	1900-1917								1909	1908
MI	Bay City	1900-1917								1909	1907
MI	Detroit	1900-1917	1908					1906		1905	1906
MI	Escanaba	1900-1917								1909	
MI	Flint	1900-1917								1910	
MI	Grand Rapids	1900-1917	1907				1910	1905		1905	1908
MI	Jackson	1900-1917		1915						1908	1916
MI	Kalamazoo	1900-1917	1914		1909			1904		1909	1912

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
MI	Lansing	1900-1917	1913							1909	1914
MI	Manistee	1906-1917	1915							1911	
MI	Marquette	1900-1917	1911							1909	1917
MI	Muskegon	1900-1917		1915						1908	
MI	Owosso	1900-1909								1908	
MI	Pontiac	1900-1917								1915	
MI	Port Huron	1900-1917								1915	
MI	Saginaw	1900-1917		1915		1909	1909	1910		1909	1909
MI	Sault Ste. Marie	1900-1917								1914	
MI	Traverse City	1900-1917								1913	
MN	Duluth	1900-1917	1912	1915	1910	1905		1905		1908	1910
MN	Mankato	1900-1917								1908	
MN	Minneapolis	1900-1917		1908	1908					1903	
MN	St. Paul	1900-1917	1914			1904				1908	1909
MN	Winona	1900-1917								1908	
MS	Jackson	1915-1917								1916	
MO	Hannibal	1911-1917								1915	
MO	Jefferson City	1911-1917								1912	
MO	Kansas City	1900-1917	1915		1909	1908	1910	1906		1907	1909
MO	St. Joseph	1900-1917						1907		1910	1911
MO	St. Louis	1900-1917		1901	1913			1903		1904	
MO	Springfield	1911-1917				1914	1914	1914	1914		
MT	Billings	1910-1917								1911	
MT	Butte	1910-1917								1912	1916
NE	Lincoln	1900-1917						1905			
NE	Omaha	1900-1917		1908						1907	1912
NH	Concord	1900-1917	1901							1908	
NH	Manchester	1900-1917				1906		1904			1916
NJ	Atlantic City	1900-1917								1907	
NJ	Bayonne	1900-1917								1912	1912
NJ	Bloomfield	1906-1917								1913	
NJ	Bridgeton	1900-1917								1906	
NJ	Camden	1900-1917								1908	1908
NJ	East Orange	1906-1917				1909	1909	1909			
NJ	Elizabeth	1900-1917				1913	1913			1906	1909
NJ	Garfield	1910-1917								1913	

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
NJ	Hackensack	1906-1917								1911	
NJ	Hoboken	1900-1917								1913	1912
NJ	Jersey City	1900-1917								1909	1910
NJ	Kearny	1906-1917									1914
NJ	Millville	1900-1917								1907	
NJ	Montclair	1900-1917								1907	
NJ	Morristown	1900-1917								1909	1909
NJ	Newark	1900-1917	1908	1909	1909	1909	1909			1909	1908
NJ	Orange	1900-1917		1906	1909	1911	1908	1908		1904	1904
NJ	Passaic	1900-1917			1909	1910	1912	1904		1913	1915
NJ	Paterson	1900-1917			1910	1905	1911			1908	1909
NJ	Perth Amboy	1900-1917				1913		1913	1913	1910	1917
NJ	Phillipsburg	1900-1917								1910	1911
NJ	Plainfield	1900-1917			1909						1913
NJ	Trenton	1900-1917		1911		1902	1902				1912
NJ	Union	1900-1917		1912							
NJ	West Hoboken	1907-1917				1914	1914	1914			
NY	Albany	1900-1917	1910		1908			1908		1908	1908
NY	Amsterdam	1900-1917								1910	1910
NY	Auburn	1900-1917	1912					1905			
NY	Batavia	1906-1917								1909	
NY	Binghamton	1900-1917	1908					1907		1907	
NY	Buffalo	1900-1917	1914	1902	1908				1910	1908	1907
NY	Cohoes	1900-1917								1909	1909
NY	Corning	1900-1917			1915					1909	1912
NY	Cortland	1900-1917								1908	
NY	Dunkirk	1900-1917								1909	1910
NY	Elmira	1900-1917	1909	1915				1903			1914
NY	Geneva	1900-1917								1908	
NY	Glens Falls	1900-1917								1910	1911
NY	Gloversville	1900-1917	1912							1911	1913
NY	Hornell	1906-1917								1909	1912
NY	Hudson	1900-1917								1909	
NY	Ithaca	1900-1917	1912							1911	1911
NY	Jamestown	1900-1917								1909	1910
NY	Johnstown	1900-1917								1910	1915

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
NY	Kingston	1900-1917		1909						1909	1910
NY	Little Falls	1906-1917								1911	1912
NY	Lockport	1900-1917								1910	1913
NY	Middletown	1900-1917								1909	1911
NY	Mount Vernon	1900-1917				1914		1907			
NY	New York	1900-1917			1907				1911	1902	
NY	Newburgh	1900-1917	1910		1914					1909	1912
NY	Niagara Falls	1900-1917				1905	1905	1905		1910	1910
NY	North Tonawanda	1906-1917								1912	
NY	Ogdensburg	1900-1917								1910	
NY	Olean	1900-1917	1916		1914					1909	1910
NY	Oswego	1906-1917								1909	
NY	Peekskill	1900-1917									1914
NY	Plattsburg	1906-1917								1910	
NY	Poughkeepsie	1900-1917	1909				1916	1907		1909	1911
NY	Rochester	1900-1917	1910	1904	1908	1912			1912		
NY	Rome	1900-1917		1913						1907	1908
NY	Saratoga Springs	1900-1917								1910	
NY	Schenectady	1900-1917		1908		1908	1908	1906	1908	1908	1908
NY	Syracuse	1900-1917	1916	1909				1908		1909	1908
NY	Troy	1900-1917	1910					1904		1908	1908
NY	Utica	1900-1917			1910					1907	1909
NY	Watertown	1900-1917						1910		1909	1910
NY	Watervliet	1900-1917								1910	1910
NY	Yonkers	1900-1917		1908						1905	1906
NC	Durham	1910-1917		1916							
NC	Raleigh	1900-1917								1909	
NC	Wilmington	1900-1917	1914			1913	1913	1913	1914		
NC	Winston-Salem	1910-1917	1917								
OH	Akron	1909-1917								1917	1916
OH	Alliance	1909-1917								1914	
OH	Ashtabula	1900-1917								1915	
OH	Bellaire	1900-1917								1912	
OH	Cambridge	1909-1917								1914	
OH	Canton	1900-1917				1907		1902		1910	1910
OH	Chillicothe	1900-1917								1908	1911

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
OH	Cincinnati	1900-1917			1910	1912	1912	1911	1912	1907	1907
OH	Cleveland	1900-1917	1905		1908	1907	1901	1905	1909	1905	1904
OH	Columbus	1900-1917				1906		1906		1906	1906
OH	Dayton	1900-1917		1903						1908	1914
OH	East Liverpool	1909-1917								1914	
OH	Elyria	1909-1917								1915	
OH	Hamilton	1900-1917		1913		1913	1912	1910	1912	1912	1912
OH	Lancaster	1909-1917								1913	
OH	Lima	1900-1917		1911						1909	
OH	Mansfield	1909-1917								1914	
OH	Marietta	1900-1917								1914	
OH	Marion	1909-1917								1912	
OH	Massillon	1900-1917								1915	
OH	Newark	1900-1917								1915	
OH	Piqua	1909-1917								1915	
OH	Portsmouth	1900-1917								1911	1914
OH	Sandusky	1909-1917								1913	
OH	Springfield	1909-1917		1910							1915
OH	Steubenville	1909-1917								1910	1917
OH	Tiffin	1900-1917								1915	
OH	Toledo	1900-1917		1909	1910					1909	1905
OH	Warren	1900, 1909-1917								1913	1914
OH	Youngstown	1900-1917		1908		1905		1902		1905	1914
OH	Zanesville	1909-1917								1914	
OR	Portland	1900-1917			1905	1909	1909	1904	1914	1909	1910
PA	Allentown	1900-1917					1902	1910		1908	1908
PA	Altoona	1900-1917				1902		1904		1913	1907
PA	Beaver Falls	1906-1917								1915	1908
PA	Braddock	1906-1917									1909
PA	Bradford	1906-1917	1908							1909	1908
PA	Butler	1906-1917								1916	1907
PA	Carbondale	1900-1917								1915	1908
PA	Carlisle	1900-1917								1915	1907
PA	Chambersburg	1906-1917									1907
PA	Chester	1906-1917								1916	1907
PA	Coatesville	1910-1917								1916	

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
PA	Columbia	1900-1917								1915	1908
PA	Danville	1906-1909									1907
PA	Dubois	1900-1917								1915	1908
PA	Easton	1900, 1906-1917								1908	1908
PA	Erie	1900-1917								1910	1907
PA	Harrisburg	1900-1917							1915	1905	1908
PA	Hazleton	1900-1917								1908	1908
PA	Homestead	1906-1917									1908
PA	Johnstown	1900-1917				1907		1903		1914	1907
PA	Lancaster	1900-1917								1908	1908
PA	Lebanon	1900, 1906-1917									1907
PA	McKeesport	1900-1917						1907			1908
PA	Meadville	1900-1917								1915	1908
PA	Mount Carmel	1900-1917									1908
PA	Nanticoke	1906-1917								1915	1910
PA	New Castle	1900-1917				1907	1907	1907			1908
PA	Norristown	1900-1917								1916	1908
PA	Oil City	1900, 1906-1917	1904								1907
PA	Philadelphia	1900-1917						1903		1903	1903
PA	Phoenixville	1900, 1906-1917									1908
PA	Pittsburgh	1900-1917		1906		1907		1906		1908	1907
PA	Pittston	1906-1917									1908
PA	Plymouth	1900-1917								1915	
PA	Pottstown	1900-1917								1916	1908
PA	Pottsville	1900-1917								1908	1908
PA	Reading	1900-1917	1910							1909	1908
PA	Scranton	1900-1917	1903			1908		1907		1903	1908
PA	Shamokin	1906-1917									1908
PA	Sharon	1906-1917								1915	1908
PA	Shenandoah	1906-1917									1908
PA	South Bethlehem	1900-1917									1908
PA	Sunbury	1906-1917								1916	1909
PA	Titusville	1906-1909									1908
PA	Warren	1906-1917	1910								1908
PA	Washington	1910-1917								1915	
PA	West Chester	1906-1917									1907

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
PA	Wilkes-Barre	1906-1917									1907
PA	Wilkinsburg	1906-1917								1908	1909
PA	Williamsport	1900-1917				1905	1905	1905		1910	1908
PA	York	1906-1917								1914	1907
RI	Cranston	1906-1917								1910	
RI	East Providence	1906-1917								1910	
RI	Newport	1900-1917				1903	1903	1902		1904	1904
RI	Pawtucket	1900-1917						1906		1908	1908
RI	Providence	1900-1917		1905	1908					1905	
RI	Warwick	1906-1917								1914	
RI	Woonsocket	1900-1917						1909		1908	1915
SC	Charleston	1900-1917								1909	1909
TN	Memphis	1900-1915, 1917		1908		1908		1905		1917	1912
TN	Nashville	1900-1915, 1917		1912		1907				1906	1911
TX	Dallas	1916-1917			1917						
TX	El Paso	1911-1917								1916	
TX	Galveston	1906-1917		1913		1907				1911	
TX	San Antonio	1900-1917	1912		1907	1908			1915	1915	
UT	Ogden	1908-1917					1911	1913	1911		
UT	Salt Lake City	1900-1917				1913	1913	1903	1913	1916	
VA	Alexandria	1900-1917								1910	
VA	Danville	1908-1917	1915								
VA	Lynchburg	1900-1917		1912		1910	1910	1910		1908	
VA	Norfolk	1900-1917			1909	1906				1906	1906
VA	Petersburg	1900-1917	1911							1908	
VA	Richmond	1900-1917			1910	1907				1909	1907
WA	Everett	1910-1917				1914	1914				
WA	Seattle	1900-1917	1911	1903		1907	1907	1907	1911	1909	1910
WA	Spokane	1901-1917	1915			1915				1911	
WA	Tacoma	1900-1917				1909	1909			1910	1915
WA	Walla Walla	1908-1917								1916	
WV	Wheeling	1900-1917				1908		1902		1909	1910
WI	Appleton	1900-1906, 1908-1917								1911	
WI	Ashland	1908-1917								1911	
WI	Eau Claire	1900-1917	1913							1909	
WI	Fond du Lac	1908-1917								1911	

Appendix Table 1. Municipal-level Anti-TB Measures, 1900-1917 (continued)

State	City	Years of available data	First sanatorium	First TB hospital	First open-air camp	Municipal reporting ordinance	Municipal disinfection ordinance	Municipal spitting ordinance	Municipal common cup ordinance	Municipal TB association	First dispensary
WI	Green Bay	1900-1917								1911	
WI	Janesville	1908-1917								1912	
WI	Kenosha	1900-1917	1916								
WI	La Crosse	1908-1917								1910	
WI	Madison	1900-1917	1917							1909	1910
WI	Manitowoc	1900-1905, 1908-1917	1912							1911	
WI	Marinette	1900-1917								1912	
WI	Milwaukee	1900-1917	1907	1907				1905		1904	1908
WI	Racine	1908-1917	1913							1909	
WI	Sheboygan	1908-1917								1910	
WI	Superior	1900-1917				1910				1908	
WI	Wausau	1908-1917	1917							1910	1911

Notes: Data on municipal-level anti-TB interventions come from *A Tuberculosis Directory*, published in 1911, 1916, and 1919 by the National Association for the Study and Prevention of Tuberculosis. Dates are listed only for cities with mortality data available before and after the specific anti-TB measure was implemented.

Appendix Table 2. State-level Anti-TB Measures, 1900-1917

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
AL					1914	
	Cities with mortality data pre- and post-state policy change				Birmingham, Mobile, Montgomery	
CA					1907	
	Cities with mortality data pre- and post-state policy change				Alameda, Berkeley, Fresno, Los Angeles, Oakland, Pasadena, Sacramento, San Diego, San Francisco, San Jose, Stockton	
CO		1911	1913	1911	1909	
	Cities with mortality data pre- and post-state policy change	Colorado Springs, Denver, Pueblo	Colorado Springs, Denver, Pueblo	Colorado Springs, Denver, Pueblo	Colorado Springs, Denver, Pueblo	
CT		1909			1909	1909
	Cities with mortality data pre- and post-state policy change	Bridgeport, Bristol, Greenwich, Hartford, Meriden, Middletown, New Britain, New Haven, New London, Norwalk, Stamford, Wallingford, Waterbury			Bridgeport, Bristol, Greenwich, Hartford, Meriden, Middletown, New Britain, New Haven, New London, Norwalk, Stamford, Wallingford, Waterbury	Bridgeport, Bristol, Greenwich, Hartford, Meriden, Middletown, New Britain, New Haven, New London, Norwalk, Stamford, Wallingford, Waterbury
DE			1914		1906	
	Cities with mortality data pre- and post-state policy change		Wilmington		Wilmington	
FL					1916	
	Cities with mortality data pre- and post-state policy change				Jacksonville, Tampa	
GA					1909	1911
	Cities with mortality data pre- and post-state policy change				Atlanta, Savannah	Atlanta, Savannah
IL			1914		1905	
	Cities with mortality data pre- and post-state policy change		Aurora, Chicago, Decatur, Evanston, Jacksonville, Quincy, Springfield		Aurora, Chicago, Decatur, Jacksonville, Ottawa, Quincy, Springfield	

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
IN		1907	1913		1907	1911
	Cities with mortality data pre- and post-state policy change	Anderson, Elkhart, Evansville, Fort Wayne, Huntington, Indianapolis, Kokomo, Lafayette, Logansport, Muncie, New Albany, Peru, Richmond, South Bend, Terre Haute	Anderson, Elkhart, Evansville, Fort Wayne, Gary, Huntington, Indianapolis, Kokomo, Lafayette, Logansport, Muncie, New Albany, Peru, Richmond, South Bend, Terre Haute		Anderson, Elkhart, Evansville, Fort Wayne, Huntington, Indianapolis, Kokomo, Lafayette, Logansport, Muncie, New Albany, Peru, Richmond, South Bend, Terre Haute	Anderson, Elkhart, Evansville, Fort Wayne, Gary, Huntington, Indianapolis, Kokomo, Lafayette, Logansport, Muncie, New Albany, Peru, Richmond, South Bend, Terre Haute
KS		1909			1908	1914
	Cities with mortality data pre- and post-state policy change	Kansas City, Wichita			Kansas City, Wichita	Kansas City, Topeka, Wichita
KY					1909	
	Cities with mortality data pre- and post-state policy change				Covington, Louisville, Newport, Paducah	
LA		1909			1906	
	Cities with mortality data pre- and post-state policy change	New Orleans			New Orleans	
ME		1895	1913		1901	1915
	Cities with mortality data pre- and post-state policy change		Auburn, Augusta, Bangor, Lewiston, Portland, Waterville		Augusta, Bangor, Portland	Auburn, Augusta, Bangor, Lewiston, Portland, Waterville
MD		1904		1912	1904	1908
	Cities with mortality data pre- and post-state policy change	Annapolis, Baltimore, Frederick		Baltimore, Cumberland, Frederick, Hagerstown	Annapolis, Baltimore, Frederick	Annapolis, Baltimore, Cumberland, Frederick, Hagerstown

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
MA		1907			1906	1908
	Cities with mortality data pre- and post-state policy change	Adams, Attleborough, Beverly, Boston, Brockton, Brookline, Cambridge, Chelsea, Chicopee, Clinton, Everett, Fall River, Fitchburg, Framingham, Gardner, Gloucester, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, Medford, Melrose, New Bedford, Newburyport, Newton, North Adams, Northampton, Peabody, Pittsfield, Plymouth, Quincy, Salem, Somerville, Springfield, Taunton, Wakefield, Waltham, Webster, Westfield, Worcester			Adams, Attleborough, Beverly, Boston, Brockton, Brookline, Cambridge, Chelsea, Chicopee, Clinton, Everett, Fall River, Fitchburg, Framingham, Gardner, Gloucester, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, Medford, Melrose, New Bedford, Newburyport, Newton, North Adams, Northampton, Peabody, Pittsfield, Plymouth, Quincy, Salem, Somerville, Springfield, Taunton, Wakefield, Waltham, Webster, Westfield, Worcester	Adams, Attleborough, Beverly, Boston, Brockton, Brookline, Cambridge, Chelsea, Chicopee, Clinton, Everett, Fall River, Fitchburg, Framingham, Gardner, Gloucester, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, Medford, Melrose, New Bedford, Newburyport, Newton, North Adams, Northampton, Peabody, Pittsfield, Plymouth, Quincy, Salem, Somerville, Springfield, Taunton, Wakefield, Waltham, Webster, Westfield, Worcester
MI		1893			1908	1907
	Cities with mortality data pre- and post-state policy change				Adrian, Alpena, Ann Arbor, Battle Creek, Bay City, Detroit, Escanaba, Flint, Grand Rapids, Jackson, Kalamazoo, Lansing, Manistee, Marquette, Muskegon, Owosso, Pontiac, Port Huron, Saginaw, Sault Ste. Marie, Traverse City	Adrian, Alpena, Ann Arbor, Battle Creek, Bay City, Detroit, Escanaba, Flint, Grand Rapids, Jackson, Kalamazoo, Lansing, Manistee, Marquette, Muskegon, Owosso, Pontiac, Port Huron, Saginaw, Sault Ste. Marie, Traverse City

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
MN			1913	1913	1908	1908
	Cities with mortality data pre- and post-state policy change		Duluth, Mankato, Minneapolis, St. Paul, Winona	Duluth, Mankato, Minneapolis, St. Paul, Winona	Duluth, Mankato, Minneapolis, St. Paul, Winona	Duluth, Mankato, Minneapolis, St. Paul, Winona
MO					1907	1907
	Cities with mortality data pre- and post-state policy change				Kansas City, St. Joseph, St. Louis	Kansas City, St. Joseph, St. Louis
MT		1913	1913	1913	1908	1913
	Cities with mortality data pre- and post-state policy change	Billings, Butte	Billings, Butte	Billings, Butte		Billings, Butte
NE		1909		1913	1907	1912
	Cities with mortality data pre- and post-state policy change	Lincoln, Omaha		Lincoln, Omaha	Lincoln, Omaha	Lincoln, Omaha
NH					1906	1909
	Cities with mortality data pre- and post-state policy change				Concord, Manchester	Concord, Manchester
NJ		1909		1911	1906	1907
	Cities with mortality data pre- and post-state policy change	Atlantic City, Bayonne, Bloomfield, Bridgeton, Camden, East Orange, Elizabeth, Hackensack, Hoboken, Jersey City, Kearny, Millville, Montclair, Morristown, Newark, Orange, Passaic, Paterson, Perth Amboy, Phillipsburg, Plainfield, Trenton, Union, West Hoboken		Atlantic City, Bayonne, Bloomfield, Bridgeton, Camden, East Orange, Elizabeth, Garfield, Hackensack, Hoboken, Jersey City, Kearny, Millville, Montclair, Morristown, Newark, Orange, Passaic, Paterson, Perth Amboy, Phillipsburg, Plainfield, Trenton, Union, West Hoboken	Atlantic City, Bayonne, Bloomfield, Bridgeton, Camden, East Orange, Elizabeth, Hackensack, Hoboken, Jersey City, Kearny, Millville, Montclair, Morristown, Newark, Orange, Passaic, Paterson, Perth Amboy, Phillipsburg, Plainfield, Trenton, Union	Atlantic City, Bayonne, Bloomfield, Bridgeton, Camden, East Orange, Elizabeth, Hackensack, Hoboken, Jersey City, Kearny, Millville, Montclair, Morristown, Newark, Orange, Passaic, Paterson, Perth Amboy, Phillipsburg, Plainfield, Trenton, Union

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
NY		1907			1907	1904
	Cities with mortality data pre- and post-state policy change	Albany, Amsterdam, Auburn, Batavia, Binghamton, Buffalo, Cohoes, Corning, Cortland, Dunkirk, Elmira, Geneva, Glens Falls, Gloversville, Hornell, Hudson, Ithaca, Jamestown, Johnstown, Kingston, Little Falls, Lockport, Middletown, Mount Vernon, New York, Newburgh, Niagara Falls, North Tonawanda, Ogdensburg, Olean, Oswego, Peekskill, Plattsburg, Poughkeepsie, Rochester, Rome, Saratoga Springs, Schenectady, Syracuse, Troy, Utica, Watertown, Watervliet, Yonkers			Albany, Amsterdam, Auburn, Batavia, Binghamton, Buffalo, Cohoes, Corning, Cortland, Dunkirk, Elmira, Geneva, Glens Falls, Gloversville, Hornell, Hudson, Ithaca, Jamestown, Johnstown, Kingston, Little Falls, Lockport, Middletown, Mount Vernon, New York, Newburgh, Niagara Falls, North Tonawanda, Ogdensburg, Olean, Oswego, Peekskill, Plattsburg, Poughkeepsie, Rochester, Rome, Saratoga Springs, Schenectady, Syracuse, Troy, Utica, Watertown, Watervliet, Yonkers	Albany, Amsterdam, Auburn, Binghamton, Buffalo, Cohoes, Corning, Cortland, Dunkirk, Elmira, Geneva, Glens Falls, Gloversville, Hudson, Ithaca, Jamestown, Johnstown, Kingston, Lockport, Middletown, Mount Vernon, New York, Newburgh, Niagara Falls, Ogdensburg, Olean, Peekskill, Poughkeepsie, Rochester, Rome, Saratoga Springs, Schenectady, Syracuse, Troy, Utica, Watertown, Watervliet, Yonkers
NC		1913			1906	1908
	Cities with mortality data pre- and post-state policy change	Durham, Raleigh, Wilmington, Winston-Salem			Raleigh, Wilmington	Raleigh, Wilmington
OH					1901	1909
	Cities with mortality data pre- and post-state policy change				Ashtabula, Bellaire, Canton, Chillicothe, Cincinnati, Cleveland, Columbus, Dayton, Hamilton, Lima, Marietta, Massillon, Newark, Portsmouth, Tiffin, Toledo, Warren, Youngstown	Ashtabula, Bellaire, Canton, Chillicothe, Cincinnati, Cleveland, Columbus, Dayton, Hamilton, Lima, Marietta, Massillon, Newark, Portsmouth, Tiffin, Toledo, Warren, Youngstown

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
OR		1903		1915	1908	1910
	Cities with mortality data pre- and post-state policy change	Portland		Portland	Portland	Portland
PA		1909		1913	1892	1907
	Cities with mortality data pre- and post-state policy change	Allentown, Altoona, Beaver Falls, Braddock, Bradford, Butler, Carbondale, Carlisle, Chambersburg, Chester, Columbia, Danville, Dubois, Easton, Erie, Harrisburg, Hazleton, Homestead, Johnstown, Lancaster, Lebanon, McKeesport, Meadville, Mount Carmel, Nanticoke, New Castle, Norristown, Oil City, Philadelphia, Phoenixville, Pittsburgh, Pittston, Plymouth, Pottstown, Pottsville, Reading, Scranton, Shamokin, Sharon, Shenandoah, South Bethlehem, Sunbury, Titusville, Warren, West Chester, Wilkes-Barre, Wilkinsburg, Williamsport, York		Allentown, Altoona, Beaver Falls, Braddock, Bradford, Butler, Carbondale, Carlisle, Chambersburg, Chester, Coatesville, Columbia, Danville, Dubois, Easton, Erie, Harrisburg, Hazleton, Homestead, Johnstown, Lancaster, Lebanon, McKeesport, Meadville, Mount Carmel, Nanticoke, New Castle, Norristown, Oil City, Philadelphia, Phoenixville, Pittsburgh, Pittston, Plymouth, Pottstown, Pottsville, Reading, Scranton, Shamokin, Sharon, Shenandoah, South Bethlehem, Sunbury, Titusville, Warren, Washington, West Chester, Wilkes-Barre, Wilkinsburg, Williamsport, York		Allentown, Altoona, Beaver Falls, Braddock, Bradford, Butler, Carbondale, Carlisle, Chambersburg, Chester, Columbia, Danville, Dubois, Easton, Erie, Harrisburg, Hazleton, Homestead, Johnstown, Lancaster, Lebanon, McKeesport, Meadville, Mount Carmel, Nanticoke, New Castle, Norristown, Oil City, Philadelphia, Phoenixville, Pittsburgh, Pittston, Plymouth, Pottstown, Pottsville, Reading, Scranton, Shamokin, Sharon, Shenandoah, South Bethlehem, Sunbury, Titusville, Warren, West Chester, Wilkes-Barre, Wilkinsburg, Williamsport, York
RI		1909			1907	1905
	Cities with mortality data pre- and post-state policy change	Cranston, East Providence, Newport, Pawtucket, Providence, Warwick, Woonsocket			Cranston, East Providence, Newport, Pawtucket, Providence, Warwick, Woonsocket	Newport, Pawtucket, Providence, Woonsocket

Appendix Table 2. State-level Anti-TB Measures, 1900-1917 (continued)

State		State reporting law	State disinfection ordinance	State common cup law	State TB association	First state-run sanatorium
SC					1913	1915
	Cities with mortality data pre- and post-state policy change				Charleston	Charleston
TN		1905			1912	
	Cities with mortality data pre- and post-state policy change	Memphis, Nashville			Memphis, Nashville	
TX		1911			1908	1912
	Cities with mortality data pre- and post-state policy change	Galveston, San Antonio			Galveston, San Antonio	El Paso, Galveston, San Antonio
UT		1913	1913		1916	
	Cities with mortality data pre- and post-state policy change	Ogden, Salt Lake City	Ogden, Salt Lake City		Ogden, Salt Lake City	
VA		1910	1908		1909	1909
	Cities with mortality data pre- and post-state policy change	Alexandria, Danville, Lynchburg, Norfolk, Petersburg, Richmond	Alexandria, Lynchburg, Norfolk, Petersburg, Richmond		Alexandria, Danville, Lynchburg, Norfolk, Petersburg, Richmond	Alexandria, Danville, Lynchburg, Norfolk, Petersburg, Richmond
WA		1903		1912	1906	
	Cities with mortality data pre- and post-state policy change	Seattle, Spokane, Tacoma		Everett, Seattle, Spokane, Tacoma, Walla Walla	Seattle, Spokane, Tacoma	
WV				1913	1908	1913
	Cities with mortality data pre- and post-state policy change			Wheeling	Wheeling	Wheeling
WI		1907	1907	1913	1908	1907
	Cities with mortality data pre- and post-state policy change	Appleton, Eau Claire, Green Bay, Kenosha, Madison, Manitowoc, Marinette, Milwaukee, Superior	Appleton, Eau Claire, Green Bay, Kenosha, Madison, Manitowoc, Marinette, Milwaukee, Superior	Appleton, Ashland, Eau Claire, Fond du Lac, Green Bay, Janesville, Kenosha, La Crosse, Madison, Manitowoc, Marinette, Milwaukee, Racine, Sheboygan, Superior, Wausau	Appleton, Ashland, Eau Claire, Fond du Lac, Green Bay, Janesville, Kenosha, La Crosse, Madison, Manitowoc, Marinette, Milwaukee, Racine, Sheboygan, Superior, Wausau	Appleton, Eau Claire, Green Bay, Kenosha, Madison, Manitowoc, Marinette, Milwaukee, Superior

Notes: Data on state-level anti-TB interventions come from *A Tuberculosis Directory*, published in 1911, 1916, and 1919 by the National Association for the Study and Prevention of Tuberculosis.

Appendix Table 3. Municipal and State Anti-TB Indices

	(1)	(2)	(3)
State Anti-TB Index	-.003 (.008)	…	…
Municipal Anti-TB Index	…	.003 (.008)	…
State and Municipal Anti-TB Index	…	…	.0001 (.007)
Mean	141.5	141.5	141.5
N	7,439	7,439	7,439
R^2	.883	.882	.882
Controlling for Municipal Anti-TB Measures Listed in Table 1?	Yes	No	No
Controlling for State Anti-TB Measures Listed in Table 1?	No	Yes	No

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Column (1): The state anti-TB index is equal to the sum of the state anti-TB measures listed in Table 1. Column (2): The municipal anti-TB index is equal to the sum of the municipal anti-TB measures listed in Table 1. Column (3): The state and municipal anti-TB index is equal to the sum of all of the anti-TB measures listed in Table 1. Controls include municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 4. Pulmonary TB Mortality and Leads and Lags of State-Run Sanatoriums

	(1)	(2)	(3)	(4)
3 Years Prior to State-Run Sanatorium	…	…	…	.005
				(.017)
2 Years Prior to State-Run Sanatorium	…	…	.021	.023
			(.030)	(.033)
1 Year Prior to State-Run Sanatorium	…	-.014	-.004	-.001
		(.017)	(.024)	(.029)
Year of State-Run Sanatorium	-.037***	-.043**	-.033	-.029
	(.013)	(.018)	(.021)	(.027)
1 Year After State-Run Sanatorium	-.049**	-.056**	-.044	-.040
	(.020)	(.025)	(.026)	(.033)
2 Years After State-Run Sanatorium	-.025	-.033	-.019	-.015
	(.023)	(.026)	(.026)	(.033)
3+ Years After State-Run Sanatorium	-.041	-.050*	-.035	-.031
	(.025)	(.029)	(.029)	(.035)
Mean	141.5	141.5	141.5	141.5
N	7,439	7,439	7,439	7,439
R^2	.883	.883	.883	.883

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1917, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of the pulmonary tuberculosis mortality rate per 100,000 population in municipality *m* and year *t*. Controls include the covariates listed in Table 1, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the state level, are in parentheses.