

How Four Once Common Diseases Were Eliminated From The American South

Lessons learned during the twentieth century can inform modern disease-control activities today.

by **Margaret Humphreys**

ABSTRACT: Four major diseases stigmatized the American South in the nineteenth and twentieth centuries: yellow fever, malaria, hookworm, and pellagra. Each disease contributed to the inhibition of economic growth in the South, and the latter three severely affected children’s development and adult workers’ productivity. However, all four had largely disappeared from the region by 1950. This paper analyzes the reasons for this disappearance. It describes the direct effects of public health interventions and the indirect effects of prosperity and other facets of economic development. It also offers insights into the invaluable benefits that could be gained if today’s neglected diseases were also eliminated. [Health Aff (Millwood). 2009;28(6):1734–44]

IN 1916 A NEW TEXTBOOK APPEARED on the “endemic diseases of the southern states.” With chapters on malaria, pellagra, and intestinal worms, the book’s authors identified the region as particularly, and peculiarly, diseased.¹ Absent was the dominant southern disease of the nineteenth century: yellow fever. Although yellow fever had traveled hand in hand with the import trade of southern cities, the twentieth-century triad of pellagra, malaria, and hookworm was inextricably linked with the rural poverty engendered by cotton culture and the tenant labor system that evolved to replace slavery after the Civil War. The rural farm worker had little money or access to health care, ate a poor diet, and lived in a subtropical landscape that was host to parasitic worms and mosquitoes. In 1916 the South’s endemic diseases appeared to be thoroughly entrenched. Later, in the depths of the Great Depression, these diseases continued to plague southerners. Yet by 1950 southerners were almost free of them all.^{2,3}

The southern liberation from disease paralleled the end of sharecropping and the rise of prosperity in the South. It also occurred in decades that saw a vast migration of rural southerners from the countryside to the city and from South to

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North. The South's farm population declined by 20 percent in the 1940s alone, when more than three million people left the region. The number of black farmers fell by 60 percent from 1920 to 1950, when 58 percent of African Americans lived in cities and towns. World War II brought jobs and the opportunity of military enlistment, boosting the economy.⁴ Mechanization replaced farm jobs, making the depopulation irreversible. By the 1920s and 1930s the city already offered very different disease ecology than the countryside.

This paper examines the interrelationship between disease and development, focusing on the four southern diseases that most stigmatized the region: yellow fever, malaria, pellagra, and hookworm. It describes the ways in which deliberate public health interventions changed the prevalence of each disease, the impact of that disease reduction on economic health, and the role of growing prosperity in promoting disease eradication. This qualitative overview reveals a complex story. Although it is at times speculative, it highlights a fertile field for future research.

The story of these four diseases fits somewhat uneasily into a series of papers on modern neglected tropical diseases. Yellow fever was anything but neglected in the nineteenth-century United States. On the contrary, it aroused national passion, spurring the formation of the first federal public health agencies. Malaria is not a “neglected” disease today, given the attention it has received from major funding agencies. But malaria, hookworm, and pellagra were diseases that emerged *from neglect* in the American South of the early twentieth century. Malaria had been known, but it was viewed as an inevitable part of life—a disease of place that could not be deliberately fought by public health action until the mosquito's role was recognized in 1898.

The other two diseases were completely neglected. Their bodily manifestations, instead of being simply signs of disease, were seen as stigmatizing individuals as belonging to lower social classes. Pellagra was not a “tropical” disease in the modern sense—it was not tied to a hot, humid climate in any direct way. But it was indirectly linked to the poverty and social heritage that the southern environment encompassed. The region as a whole suffered from the indigenous poverty that marks many developing areas around the world today, and its relationship with disease offers interesting lessons for modern development.

Yellow Fever

Yellow fever is caused by a virus carried by mosquitoes of a particular genus, *Aedes*. These mosquitoes travel easily on ships and thrive in urban landscapes that offer freshwater breeding sites. Yellow fever caused major epidemics in the Northeast in the Colonial era and early years of the Republic. But by the second decade of the nineteenth century it had become an exclusively southern disease. Wilmington, Charleston, Mobile, Galveston, and other southern cities suffered from the disease, but New Orleans was a particular target. It was free of the disease for only one year in the two decades before the Civil War. After the war's end,

a devastating epidemic spread out of New Orleans in 1878, traveling up the river and rail lines as far north as Ohio. One estimate put the damage at 10,000 lives and 100,000 cases, with millions of dollars lost in trade.⁵

■ **National impact.** The 1878 epidemic spurred a national reaction. Congress enacted the first federal health agency, the National Board of Health, although it survived only until 1884. Although northerners pitied the carnage and collected money for the yellow fever victims, others lambasted the South for its filthy, careless ways.⁶ Health authorities progressively tightened quarantines, and epidemics after 1880 seem to have been introduced by smugglers who avoided the official trade routes. When yellow fever broke out in Jacksonville in 1888, the Marine Hospital Service took over the task of limiting the epidemic. This agency evolved into the U.S. Public Health Service after the turn of the century. In 1905 the last yellow fever epidemic struck New Orleans, and the Public Health Service was able to bring it to heel using mosquito control techniques based on the work of U.S. Army surgeon Walter Reed and his colleagues in Havana in 1900.⁵

■ **Eradication.** The threat of yellow fever affected the financial growth of ports in the South, as shippers were loath to send their goods to a port that might be precipitously closed by quarantines. Yellow fever retreated from northern cities by 1830, perhaps as a result of changes in the sugar trade.⁷ After 1878 most shipping in the South that came from a port where yellow fever prevailed went through a quarantine that isolated infected people and pumped ships' holds full of acidic gas. Meant to kill the supposed yellow fever germ, the gas effectively destroyed mosquitoes as well. Key to the eradication of yellow fever in the United States was control at its source in Havana by 1910.⁸

Malaria

Malaria once ranged widely on the North American continent, extending as far north and west as New England, Ontario, Minnesota, and California. It particularly plagued the upper Mississippi Valley in the Antebellum era and affected settlement patterns throughout the southern colonies. One type of malaria, *falciparum*, brought to the continent by African slaves, was limited to the warmer environments south of the Ohio River. Another type, *vivax*, traveled with European settlers and spread with them throughout the temperate zones of North America. Both organisms are carried in the United States by the *Anopheles* mosquito species, which breeds in still water, such as ponds, swamps, and bayous.

By the twentieth century malaria was largely a southern disease. Even before the mosquito was identified as a vector in 1898, mosquito habitats had been destroyed by settlement throughout much of the country. The disease had been diminished by access to cheap quinine. Only in the South did frontier conditions persist and the disease thrive.^{9,10}

Both *falciparum* and *vivax* malarial organisms rupture red blood cells, causing anemia. *Falciparum* is deadlier; when enough parasites clog the capillaries of kid-

neys or brain, death can result. Malaria parasites can likewise clog the placenta in pregnant women, killing or damaging the fetus. A child with malaria, if not killed outright, suffers stunted growth, lethargy, and decreased cognitive development. An adult with chronic malarial infection is often listless and weak. Malaria is, in short, an enervating disease that robs a community of vigor and productivity.¹⁰

■ **Scientific breakthroughs.** Deliberate antimalarial work began in the early 1900s after William C. Gorgas, a U.S. Army physician who later served as the Army's surgeon general, had demonstrated the possibilities of malarial control in the Panama Canal Zone. During World War I the army attempted to control mosquitoes around military bases and wartime industries by oiling breeding places, screening barracks, and spraying insecticides. After the war the Rockefeller Foundation set up demonstration projects in the Mississippi Delta to discover which means of malaria control were most cost-effective and realistic. They tested preventive use of quinine, screening, and larval control. All worked well in the first couple of years of the studies; all showed some regression when local authorities had to assume responsibility. During the 1920s the use of medication as a public health measure receded, and most campaigns during that era focused on mosquito control.¹⁰

■ **Eradication.** Malaria became a disease of the rural countryside by the end of the 1920s. Cities and towns drained wetlands in the process of development and took active steps to control mosquitoes. Easy access to cheap medication in town likely also played a role. But malaria persisted on the farm, and it surged in the 1930s as many southerners returned to the land. Although New Deal programs included drainage projects to combat malaria, these were poorly planned and likely had little impact. More important were agricultural programs that paid landowners to take land out of production and other measures that resulted in the depopulation of the southern countryside. By World War II, malaria had become rare in the South. After the war the newly formed Communicable Disease Center sprayed the insecticide DDT within a million southern homes. In 1949 the center announced that malaria had been eradicated in the United States.¹⁰

■ **Impact in the South.** It is difficult to quantify the impact of malaria on southern development. One historian, who assumed that malaria was largely controlled in the 1920s, found that malaria eradication raised income in the "malaria-free" generation born in the next decade by 15 percent.^{11,12}

There was a significant drop in malaria mortality in the 1920s, but mortality is a weak measure of prevalence for a disease such as malaria. Many of its victims were too poor to see a physician or be accurately diagnosed, and most cases of malaria do not end in death. And it can be difficult to apply recent evaluations of malaria and development that focus on falciparum malaria in tropical countries to the biracial, subtropical South with its mixed infections of falciparum and vivax. Still, it seems highly likely that this disease was greatly debilitating to the vulnerable populations it affected, and its eradication had a positive impact on the health and productivity of both children and adults in the American South.

Pellagra

As noted above, pellagra is a disease caused by a deficiency of niacin (or the amino acid tryptophan, which the body converts to niacin) in the diet. Severe cases are marked by dermatitis, diarrhea, dementia, and coma leading to death.¹³ Nearly 100,000 deaths in the United States were attributed to pellagra in the first four decades of the twentieth century, making it the most severe nutritional deficiency disease in U.S. history. Most of those deaths occurred in the South, and blacks and women bore the brunt of the disease.¹⁴ There were many cases for each death, as death represents only the extreme end of the spectrum of disease. Pellagra was seasonal, striking in the spring when stored food was exhausted and the new crop and the money it brought were still months away.¹⁵

It is not obvious when pellagra first emerged as a significant health problem in the South. It is likely that pellagra afflicted at least some slaves in the Antebellum era.¹⁶ But the cases among African Americans were largely invisible even after physicians became aware of the disease in the early twentieth century. What is clear is that the disease burst into medical consciousness in the first decade of the twentieth century. In 1906 and 1907 physicians began to report epidemics of pellagra in southern orphanages and asylums. Mill owners in North and South Carolina found their workers enfeebled by the new plague, which left them too weak to work. By 1914 one estimate counted 50,000 cases of pellagra in the South.

■ **Causes.** The assumption at the time was that pellagra was caused by some as yet unidentified infectious agent, perhaps spread by a fly. Others noted the association of diets rich in corn with the presence of the disease, and they posited that moldy cornmeal was the causative agent.¹⁷

In retrospect, a change in the way that cornmeal was processed for market most likely explains the sudden appearance of pellagra. Midwestern corn was increasingly processed in large mills, packaged in bulk, and shipped by railroad throughout the country. In the first decade of the twentieth century these mills installed new machines, which removed much of the corn germ to increase the meal's shelf life. It also reduced the small amount of available niacin in cornmeal by as much as 40 percent. Institutions bought their cornmeal in bulk from these Midwestern mills, and the loss of niacin tipped vulnerable, otherwise malnourished populations over the edge into pellagra.¹⁸

But in 1914 the cause of pellagra was still a mystery, and the U.S. Public Health Service sent one of its physicians, Joseph Goldberger, to investigate it. After ruling out an infectious agent, Goldberger targeted the inadequate diets of institutionalized people as the likely cause. Through experiments on orphans, on prisoners, and later on dogs, he sought the "pellagra preventive factor" that would cure the disease. Other diseases such as beriberi and scurvy had previously been tied to specific vitamins. Goldberger was sure that pellagra would prove to be similar, and he showed that certain foods, such as brewer's yeast, eggs, milk, and meat,

were rich in the preventive factor. In 1937 Conrad Elvehjem at the University of Wisconsin identified niacin as the substance deficient in people with pellagra.¹⁹

■ **Peak and decline.** In the meantime, pellagra continued to claim lives. Its incidence peaked after a 1927 flood forced thousands of poor farmers in the Mississippi Delta into refugee camps, and again in the early 1930s as the Great Depression took hold. But then it began a slow decline, and the decline accelerated in the 1940s. The Red Cross and other public health agencies distributed brewer's yeast after the flood. Physicians became increasingly aware of the disease and how to treat it.

Although the early 1930s brought great poverty, many people moved during that period from the jobless towns back to the land, where they could grow some subsistence foods. Home extension agents offered information about garden plots and canning, contributing to improved nutrition. Grocery store chains such as Piggly Wiggly, A&P, and Kroger spread to the small towns of the South, bringing cheaper groceries to an increasingly mobile population.²⁰

The final phase of advances against pellagra came during World War II. A recovering economy meant better nutrition and access to health care. Although growing prosperity decreased the rate of pellagra, specific programs to enrich the nutrition content of foods were most important in these final stages. With niacin, thiamine, and riboflavin now identified as important nutrients, bakers began in 1938 to voluntarily fortify flour with high-vitamin yeast and later with specific vitamins. By the end of the 1940s, twenty-six states had enrichment laws, and most wheat flour, cornmeal, and grits were enriched with niacin. After such a law was enacted in Mississippi, the pellagra rate dropped from 101 per 100,000 in 1946 to fewer than 1 per 100,000 in 1947.²¹

Hookworm

Hookworm disease was once associated so much with the South that when a baseball commentator referred to southern players as coming from the "Hookworm Belt" in 1947, the phrase needed no explanation.²² The hookworm is a tiny parasite that latches onto the wall of the small intestine, secretes an anticoagulant to promote bleeding, and feeds on the host's blood. About 110 worms can consume a teaspoon of blood a day. A well-fed host with adequate iron intake can usually replace the lost iron and plasma proteins of a mild infection, but a malnourished person harboring sizable numbers of parasites will become anemic and protein deficient. In children the disease stunted physical and cognitive development. It made them weak, apathetic, and perpetually tired.²³

The hookworm's presence in the South was tied to its ecology and history. The worm probably arrived in the bodies of enslaved Africans. Hookworm eggs in human feces thrive in warm, sandy soils, where they hatch into larvae. The coastal plains of the South provided a particularly suitable environment for the worm. The frequent absence of sanitary facilities meant that the eggs remained in the surface environment. The hatched larvae waited for bare feet to come by, burrowed

between toes, and from there traveled in the bloodstream to the lungs, where they broke through the alveolar wall. Coughed up by the host, the larvae made the final part of the journey down the esophagus to the intestines.²⁴

■ **Rockefeller campaign.** Hookworm no doubt caused anemia and lassitude in the centuries before 1900, but no one in the American South identified the parasite, even though the disease was known in Europe. In 1902, however, Charles Stiles, a medical zoologist, recognized in southerners the same symptoms he had seen among European hookworm victims. Once he started looking, he found a startling prevalence of the disease. He convinced representatives of the Rockefeller Foundation to take up the cause of hookworm eradication, and in 1909 the philanthropy launched an all-out assault on the disease. Their initial surveys found 43 percent of those surveyed to be infected with hookworm; in some areas the percentage rose into the 90s.²⁵

The Rockefeller campaign stressed education, treatment, and the assumption by local and state boards of health of the responsibility to carry on what the foundation had begun. With a million dollars in their coffers, the Rockefeller men spread across the South, offering lantern shows about the hookworm, testing and treating individuals, and pushing the construction of sanitary privies. Surveys of rural schools and churches found that 80 percent lacked any sort of privy; private homes were even less likely to have sanitary facilities. Children of all classes went barefoot in the summer, often not wearing shoes until they were teenagers. By 1914, when Rockefeller ended its U.S. campaign, the prevalence of infection had been cut to 39 percent, but the message of hookworm and its implications was now well known throughout the South. The campaign also energized southern public health, leaving a legacy of empowered institutions on the state and local levels.²⁵

The campaign did not eradicate hookworm from the South, and it is difficult to know the detailed slope of the disease's decline. Hookworm was not a disease that health departments were required to report, and it rarely caused death. Only stool surveys could identify it with precision—a method of research that required much personnel and dedication. Rockefeller declared victory in the late 1920s, but others wrote of widespread hookworm in the South during the Great Depression. One physician²⁶ noted in 1924 that in rural Georgia, the prevalence of clinical hookworm did decline significantly after the campaign but that it was worse again, as would be expected if permanent sanitary improvements did not follow medical therapy. In Covington County, Alabama, 99 percent of rural schoolchildren were infected in the early 1920s.²⁶ Observers in the 1930s and 1940s acknowledged that hookworm was less widespread and less severe than it had been before, but it was still a problem.^{27,28}

■ **Persistence of the disease.** Surveys in the 1950s found that hookworm persisted in the poor, sandy coastal plains of the South. In southern Alabama, where 37 percent of schoolchildren were positive in 1937, 17 percent had hookworm eggs in

their stools in 1954.²⁹ Likewise, in east Texas, 33.4 percent of specimens sent to the state laboratory were positive for the disease.³⁰ Even in the 1960s there was persistent infection in coastal South Carolina (3 percent)³¹ and eastern Kentucky (14 percent).³² One source reported that hookworm prevalence in southern Georgia went from 60 percent in 1910 to 13 percent in 1964 and to 6 percent in 1970.³³ It is likely that hookworm persists to some degree in the contemporary South. One 1987 survey of migrant farm workers in North Carolina found that more than half of the Central American workers carried hookworms, and 6 percent of the Mexican workers did. These immigrants frequently worked barefoot or wore sandals, and bathroom facilities were not always available near the fields where they worked.³⁴

Hookworm disease has a profound effect on the developing child, and it weakens the working adult. Although early-twentieth-century newspapers parodied the disease as the “germ of laziness,” it could equally have been dubbed the “germ of stupidity.”³⁵ Modern researchers have correlated cognitive delay with hookworm disease, and the zoologist Stiles noted that children with hookworm were likely to be behind their appropriate grade in school or tracked into the lowest-performing strata of their grades.³⁶

■ **Impact of eradication.** Historians have attempted to correlate the eradication of hookworm with economic productivity. One attributed the rise in agricultural production during the 1910s to the hookworm campaign and subsequent increases in workers’ energy.³⁷ Another scholar found that increases in school enrollment, attendance, and literacy followed the Rockefeller intervention and that the children of the treated cohort had substantial gains in long-term incomes.³⁸ These scholars may overestimate the impact of the Rockefeller campaign (the disease was not neatly eradicated between 1909 and 1914), but it is likely that the growing awareness of the disease among teachers, physicians, and children may well have had its major impact in the 1910s, even if the disease was not gone by the end of that decade.

Hookworm’s decline can be attributed to a number of causes. Foremost were Stiles’ pivotal recognition of the disease and the clarion call amplified by the Rockefeller campaign that this disease was common, easy to treat, and easy to prevent. Concerns about typhoid, which was frequently fatal, drove the cities to put in sewers and running water, and fears that the privies of the poor would infect the affluent meant that even the poorer sections of towns had sanitary waste disposal throughout much of South in the 1920s.³⁹ Slowly the expectation grew that the sanitary privy was essential for adequate housing. In North Carolina in the 1940s, the state board of health required them by law.

Children increasingly wore shoes, at least to school. More children were in school, and for more years, decreasing their chances of acquiring larvae even if the larvae were prevalent around their homes. (In south Georgia only a third of houses had sanitary facilities in 1948).⁴⁰ Schoolchildren learned about hookworm in their classes, and physicians were likewise more conscious of the disease. The severe case of hookworm became rare; one World War II physician reported that 18 per-

cent of men from southern coastal states had hookworm when surveyed, but all had been well enough to pass the initial physical and serve in the Pacific theatre.⁴¹ All told, the disappearance of severe hookworm disease probably made southern workers more intelligent and energetic, increasing their productivity.

Conclusion

All four of these debilitating diseases could and did affect the same population, creating an additive and perhaps synergistic effect. The child with malaria and hookworm had pale red cells deficient in iron and oxygen transport capacity and had fewer such cells because malaria had destroyed so many. Malnutrition would have weakened the child's body even further.

In a region with weak mortality reporting and largely absent morbidity data, it is difficult to pin down exactly when these various diseases disappeared. One can question historians who assume that hookworm and malaria were so reduced by 1930 that conclusions about child development and worker productivity can be drawn accurately. None of this happened in the blink of an eye, except perhaps the disappearance of pellagra with enrichment programs. But it did happen. By the end of World War II, the major debilitating diseases of the South had ceased to burden the region.

An important determinant of this change was the development of cities and towns, and the movement of southerners from the rural landscape. In town, wage labor made the purchase of nourishing food within reach, at least sometimes. Town governments controlled mosquitoes. Doctors who would not make house calls to rural areas, or charged fees per mile traveled, were much cheaper in town, and drugs were available from the nearby pharmacy. Urban dwellings had sanitary privies or flush toilets. Driven by the fear of contagion, the affluent funded such amenities even for the poor. Children in urban schools were expected to wear shoes, and chain stores brought the prices of such shoes within the reach of many.

Of course, town life had its price. Infectious diseases such as tuberculosis, measles, and influenza now threatened. However, these would be controlled through medication and vaccines by the 1960s, in a subsequent triumph of science and public health.⁴²

IT IS HARD TO UNDERESTIMATE THE DEVASTATION that pellagra, hookworm, and malaria brought to generations of southern minds and bodies. Many southerners were, as their stereotypes indicated, made stupid and lazy by these diseases. But once rid of this burden, they were in a position to take advantage of the educational and economic opportunities that characterized the postwar United States. This physical change should not be forgotten by historians attempting to understand the massive transformations that characterized this region from the end of World War II to the present. The complexity of this story illustrates the lesson that prosperity alone will not contain disease; each disease has

its own etiology, and interventions must be tailored to their specific life histories. The lesson is surely applicable to today's neglected diseases—as is the notion that the benefits to human beings will be incalculable.

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NOTES

1. Deaderick WH, Thompson L. The endemic diseases of the southern states. Philadelphia (PA): W.B. Saunders Co.; 1916.
2. Martin MG, Humphreys ME. Social consequences of disease in the American South, 1900–World War II. *South Med J.* 2006;99(8):862–4.
3. Savitt TL, Young JH, editors. Disease and distinctiveness in the American South. Knoxville (TN): University of Tennessee Press; 1987.
4. MacLean N. From the benighted South to the sunbelt: the South in the twentieth century. In: H. Sitkoff, editor. *Perspectives in modern America: making sense of the twentieth century.* New York (NY): Oxford University Press; 2001. p. 202–26.
5. Humphreys M. *Yellow fever and the South.* New Brunswick (NJ): Rutgers University Press; 1992.
6. Blum EJ. The crucible of disease: trauma, memory, and national reconciliation during the yellow fever epidemic of 1878. *J South Hist.* 2003;69(4):791–820.
7. Goodyear JD. The sugar connection: a new perspective on the history of yellow fever. *Bull Hist Med.* 1978;52(1):5–21.
8. Espinosa, M. The threat from Havana: southern public health, yellow fever, and the U.S. intervention in the Cuban struggle for independence, 1878–1898. *J South Hist.* 2006;72(3):541–68.
9. Ackerknecht EH. *Malaria in the upper Mississippi Valley, 1760–1900.* Reprint ed. New York (NY): Arno Press; 1977.
10. Humphreys M. *Malaria: poverty, race, and public health in the United States.* Baltimore (MD): Johns Hopkins University Press; 2001.
11. Bleakley H. Economic effects of childhood exposure to tropical diseases. *Am Econ Rev.* 2009;99(2):218–23.
12. Bleakley H. *Malaria eradication in the Americas: a retrospective analysis of childhood exposure [working paper].* Chicago (IL): University of Chicago; 2007 Aug [cited 2009 Sep 20]. Available from: http://home.uchicago.edu/~bleakley/Bleakley_Malaria_August2007.pdf
13. Carpenter KJ. Effects of different methods of processing maize on its pellagrigenic activity. *Fed Proc.* 1981;40(5):1531–5.
14. Marks HM. Epidemiologists explain pellagra: gender, race, and political economy in the work of Edgar Sydenstricker. *J Hist Med Allied Sci.* 2003;58(1):34–55.
15. Miller DF. Pellagra deaths in the United States. *Am J Clin Nutr.* 1978;31(4):558–9.
16. Kiple KF, Kiple VH. Black tongue and black men: pellagra and slavery in the antebellum South. *J South Hist.* 1977;43(3):411–28.
17. Etheridge EW. *The butterfly caste: a social history of pellagra in the South.* Westport (CT): Greenwood Publishing Co.; 1972.
18. Sydenstricker VP. The history of pellagra, its recognition as a disorder of nutrition, and its conquest. *Am J Clin Nutr.* 1958;6(4):409–14.
19. Kraut AM. *Goldberger's war: the life and work of a public health crusader.* New York: Hill and Wang; 2003.
20. Mayo JM. *The American grocery store: the business evolution of an architectural space.* Westport (CT): Greenwood Press; 1993.
21. Park YK, Sempos CT, Barton CN, Vanderveen JE, Yetley EA. Effectiveness of food fortification in the United States: the case of pellagra. *Am J Public Health.* 2000;90(5):727–38.

22. Tygiel J. *Baseball's great experiment: Jackie Robinson and his legacy*, expanded ed. New York (NY): Oxford University Press; 1997. p. 186.
23. Hall A, Hewitt G, Tuffrey V, de Silva N. A review and meta-analysis of the impact of intestinal worms on child growth and nutrition. *Matern Child Nutr.* 2008;4 Suppl. 1:118–236.
24. Schad GA, Nawalinski TA, Kochar V. Human ecology and the distribution and abundance of hookworm populations. In: Croll NA, Cross JH, editors. *Human ecology and infectious diseases*. New York (NY): Academic Press; 1983. p. 187–223.
25. Ettling J. *The germ of laziness: Rockefeller philanthropy and public health in the new South*. Cambridge (MA): Harvard University Press; 1981.
26. Smillie WG. Control of hookworm disease in south Alabama. *South Med J.* 1924;17(28):494–9.
27. Stiles CW. Is it “fair to say that hookworm disease has almost disappeared from the United States?” *Science.* 1933;77(1992):237–9.
28. Andrews J. New methods of hookworm disease investigation and control. *Am J Public Health Nations Health.* 1942;32(3):282–8.
29. Hosty TS, Wells DM, Freear MA, Whitfield NK. Hookworm in Alabama. *J Med Assoc State Ala.* 1954;23(7):179–82.
30. Henderson HE. Incidence and intensity of hookworm infestation in certain East Texas counties with comparison of technics. *Tex Rep Biol Med.* 1957;15(2):283–91.
31. DiSalvo AF, Melonas J. Intestinal parasites in South Carolina, 1969. *J S C Med Assoc.* 1970;66(10):355–8.
32. Fulmer HS, Huempfer HR. Intestinal helminths in eastern Kentucky: a survey in three rural counties. *Am J Trop Med Hyg.* 1965;14:269–75.
33. Pawlowski ZS, Schad GA, Stott GJ. *Hookworm infection and anaemia. Approaches to prevention and control*. Geneva: World Health Organization; 1991.
34. Ciesielski SD, Seed JR, Ortiz JC, Metts J. Intestinal parasites among North Carolina migrant farmworkers. *Am J Public Health.* 1992;82(9):1258–62.
35. Watkins WE, Pollitt E. “Stupidity or worms”: do intestinal worms impair mental performance? *Psychol Bull.* 1997;121(2):171–91.
36. Stiles CW. Hookworm disease in certain parts of the South: a new plan of attack. *South Med J.* 1932; 25(2):189–92.
37. Brinkley G. The impact of improving health upon economic growth: an economic analysis of the southern hookworm eradication campaign, 1910–1920 [working paper]. Available from: <http://trc.davis.edu/gbrinkley>
38. Bleakley H. Disease and development: evidence from hookworm eradication in the American South. *Q J Econ.* 2007;122(1):73–117.
39. Troesken W. *Water, race, and disease*. Cambridge (MA): MIT Press; 2004.
40. McCroan JE Jr. Present status of the hookworm problem in Georgia. *J Med Assoc Ga.* 1948;37(11):434.
41. Loughlin EH. Hookworm infections in American servicemen with reference to the establishment of *ancylostoma duodenale* in the southern United States. *J Am Med Assoc.* 1948;136(3):157–61.
42. Roberts SK. *Infectious fear: politics, disease, and the health effects of segregation*. Chapel Hill (NC): University of North Carolina Press; 2009.