Public Health Efforts and the Decline in Urban Mortality

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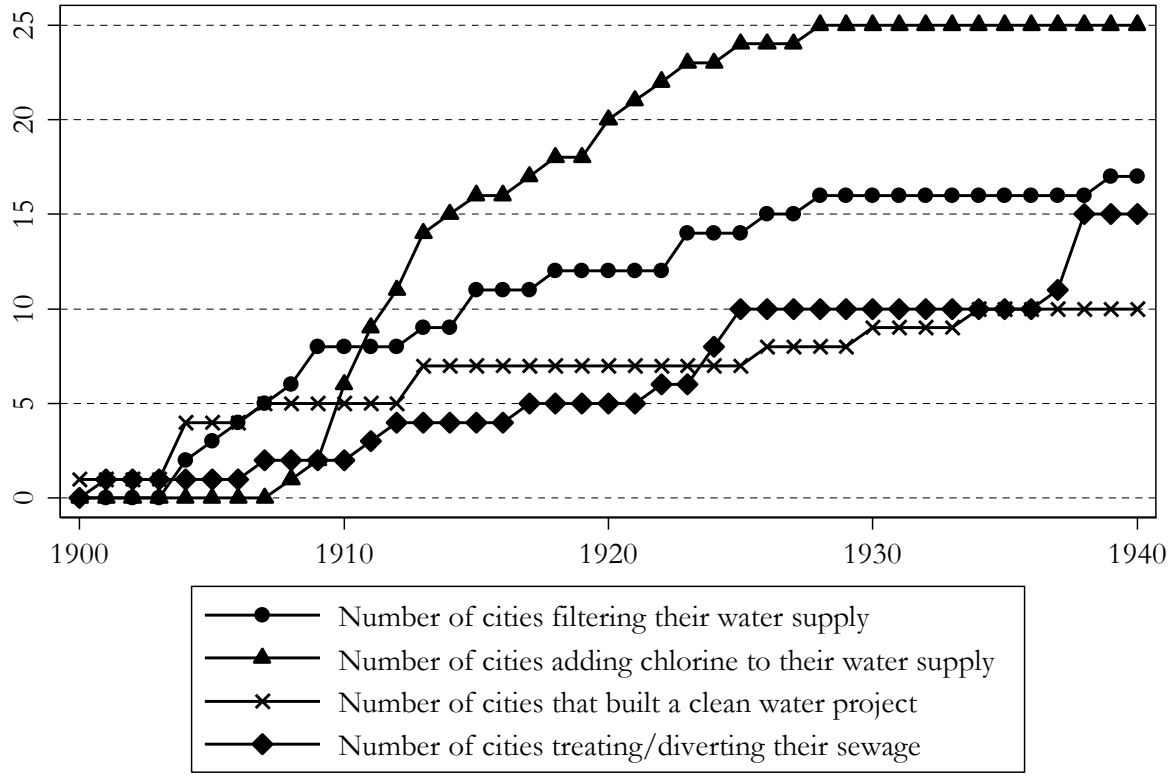
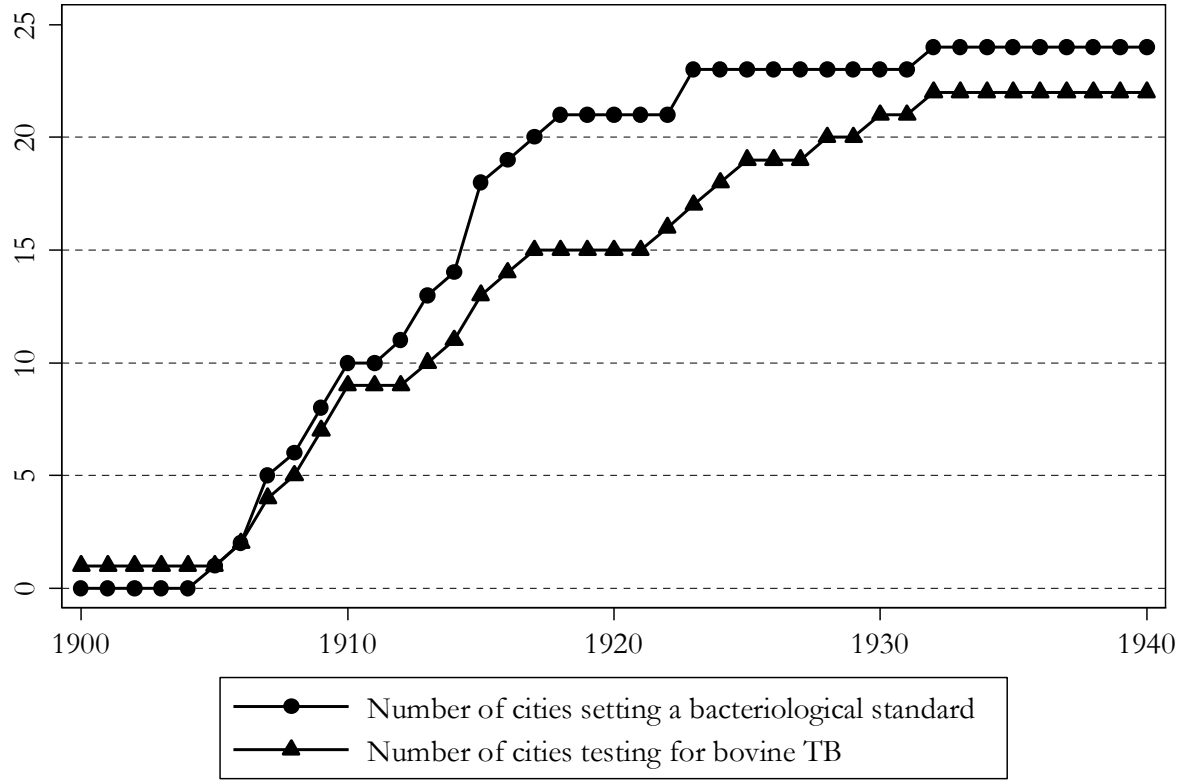
Online Appendix

Appendix A

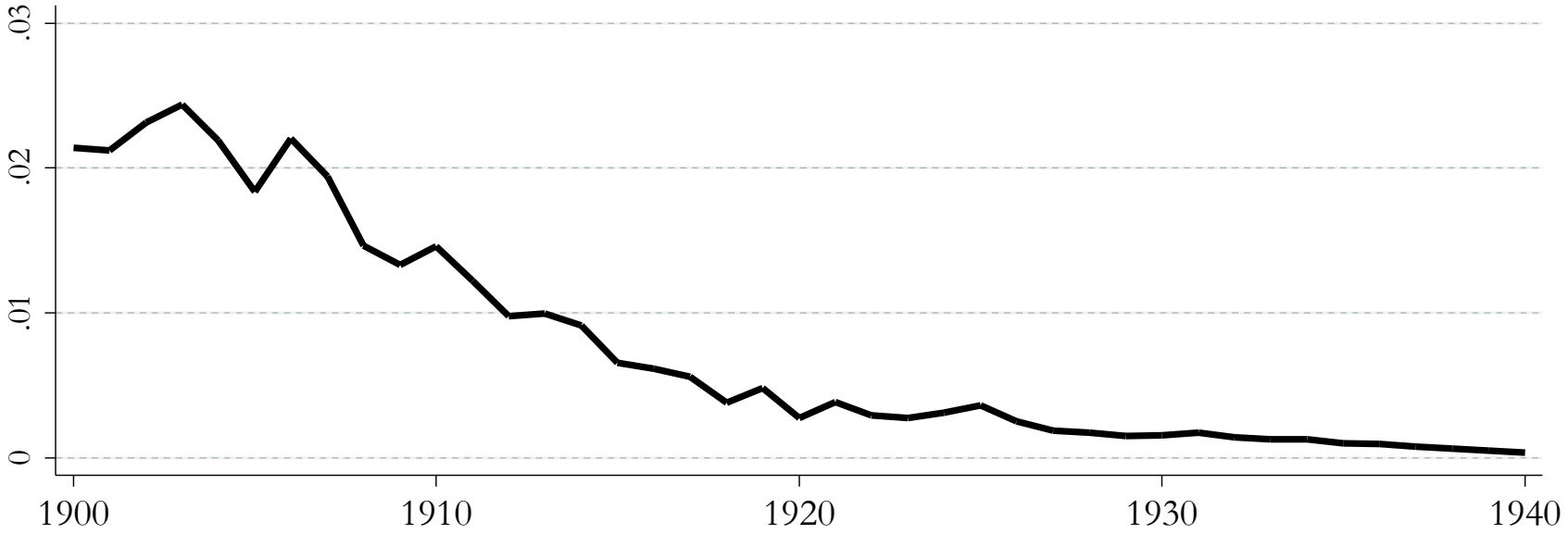
Appendix Figure 1. Municipal Water-Related Interventions Over Time



Appendix Figure 2. Municipal Milk-Related Interventions Over Time



Appendix Figure 3. Percent of Overall Mortality Due to Typhoid, 1900-1940

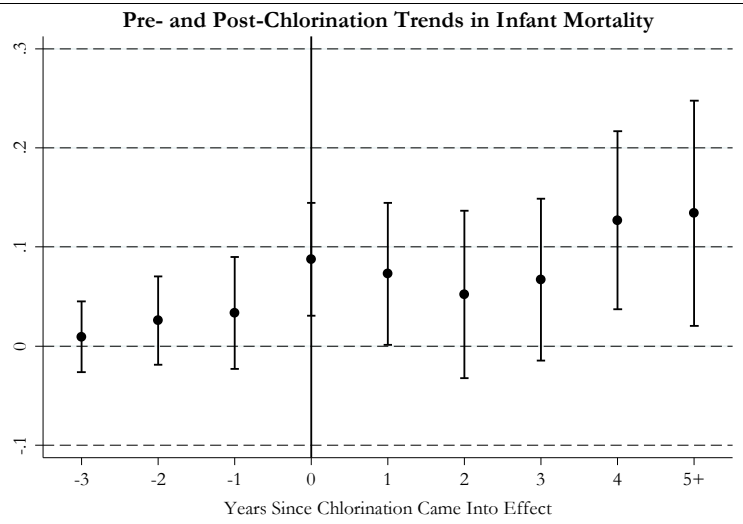


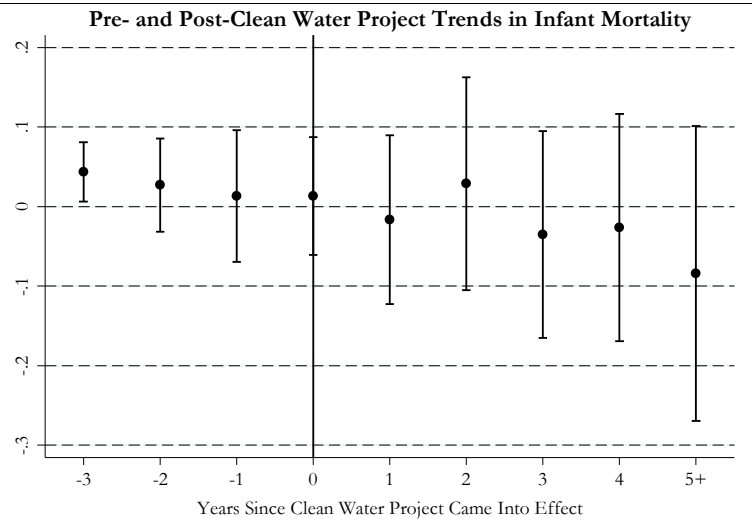
Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1940, published by the U.S. Census Bureau.

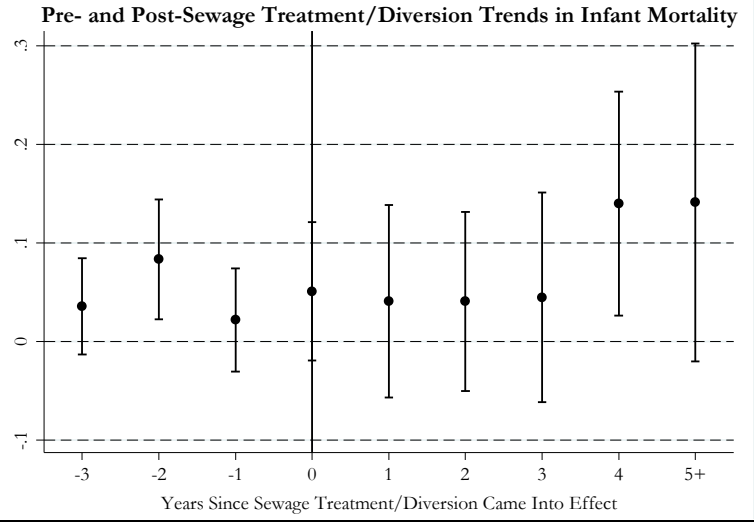
Appendix Figure 4. Ratio of Diarrhea/Enteritis to Typhoid Mortality, 1900-1938

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1938, published by the U.S. Census Bureau.

Appendix Figure 5

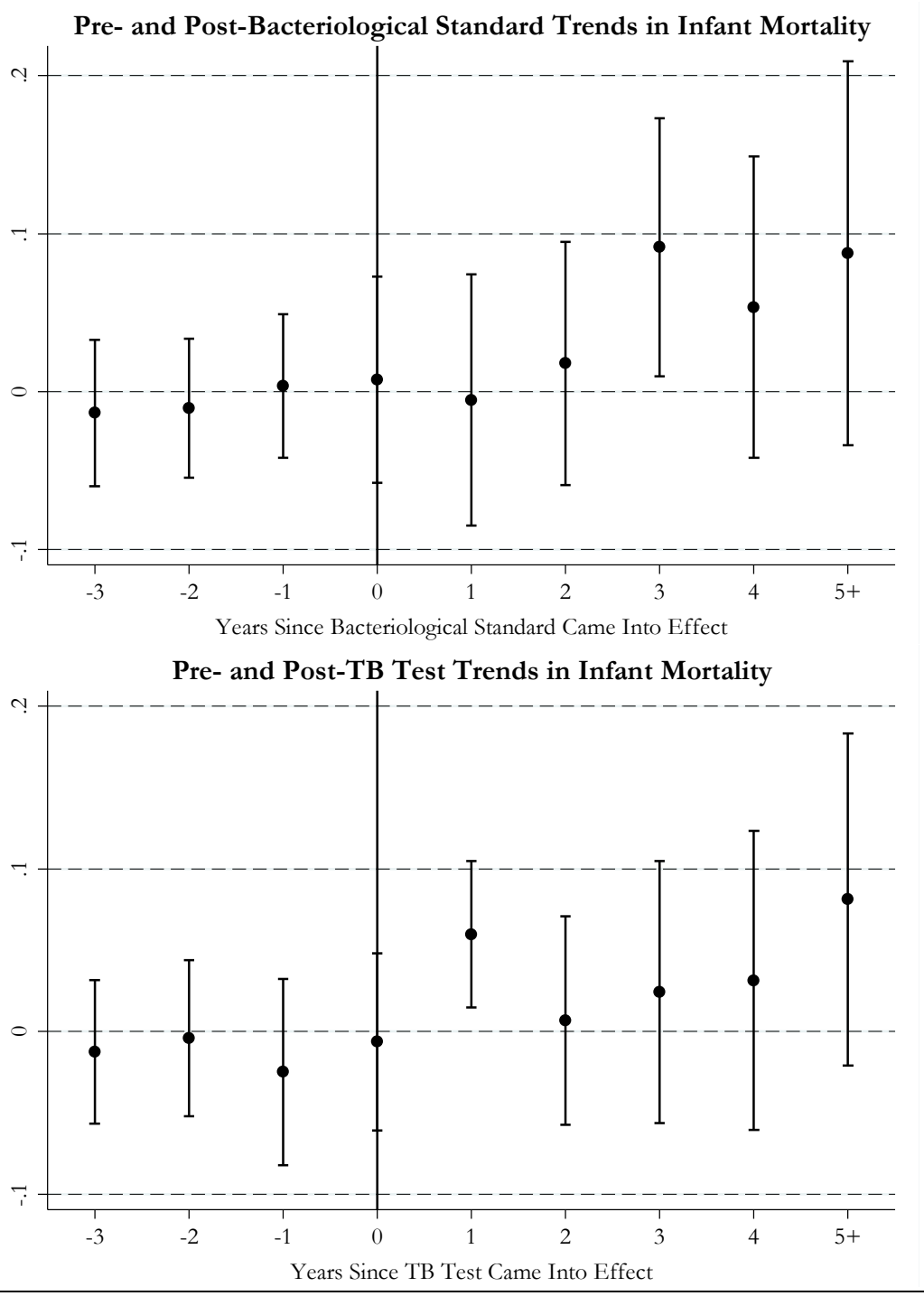






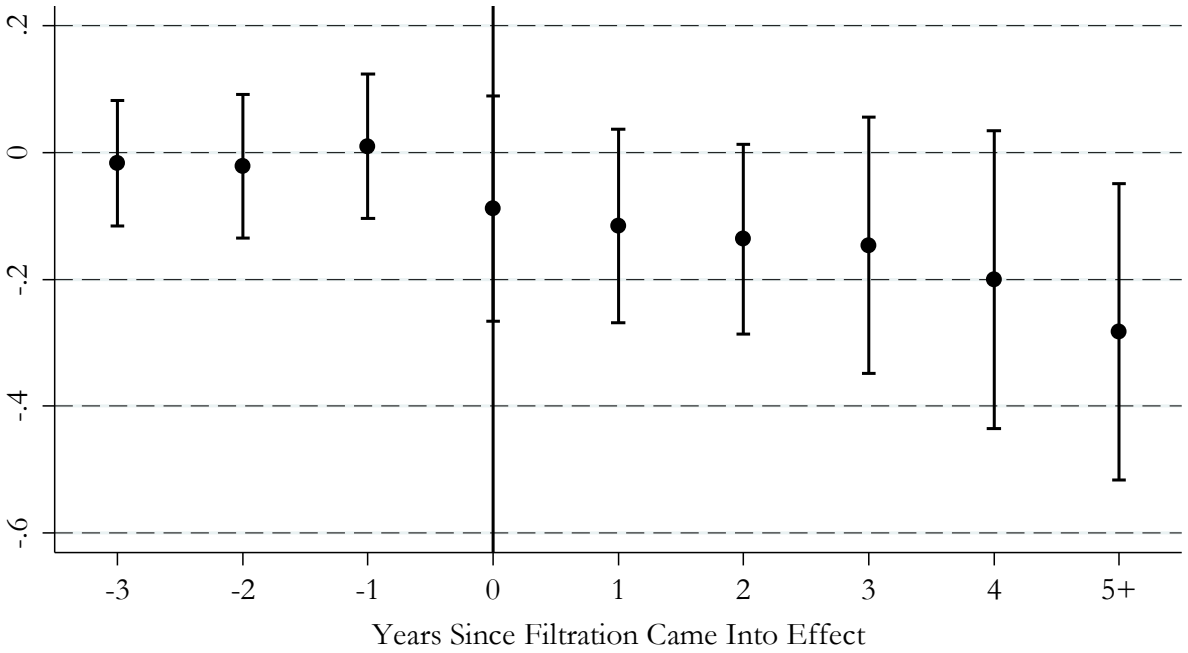
Notes: OLS coefficient estimates (and their 90% confidence intervals) are reported. The dependent variable is equal to the natural log of the number of infant deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics and remaining public health interventions listed in Table 5, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors are corrected for clustering at the municipal level.

Appendix Figure 6



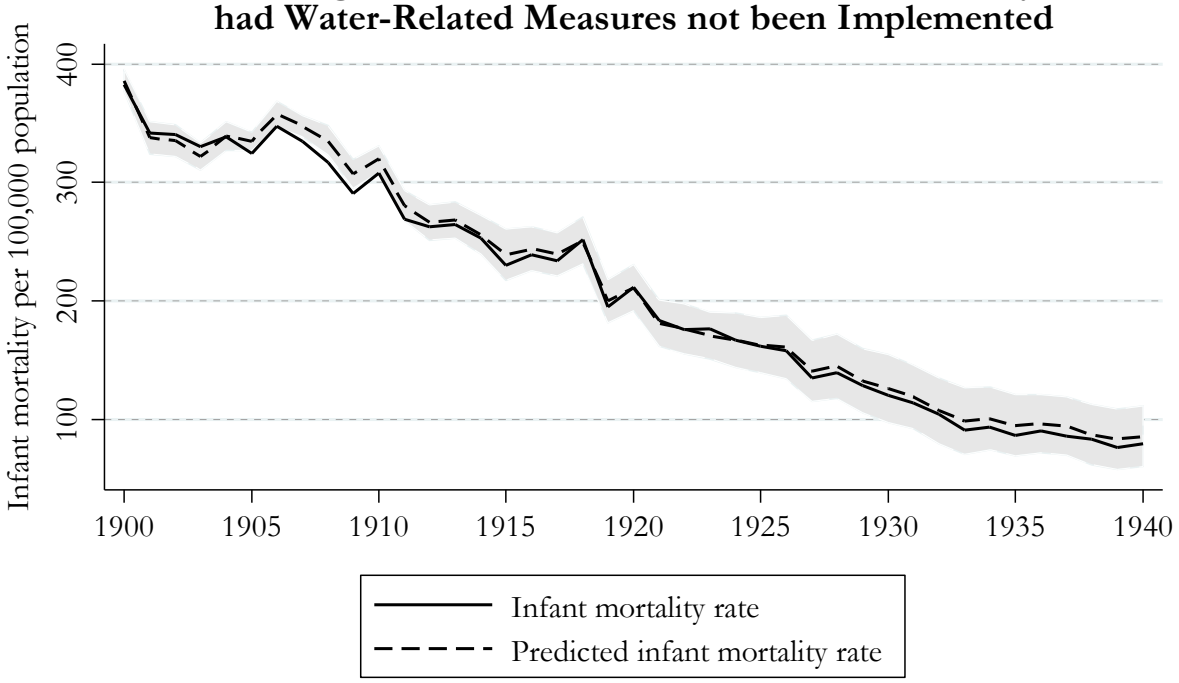
Notes: OLS coefficient estimates (and their 90% confidence intervals) are reported. The dependent variable is equal to the natural log of the number of infant deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics and remaining public health interventions listed in Table 5, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors are corrected for clustering at the municipal level.

Appendix Figure 7. Pre- and Post-Filtration Trends in Diarrhea/Enteritis Mortality



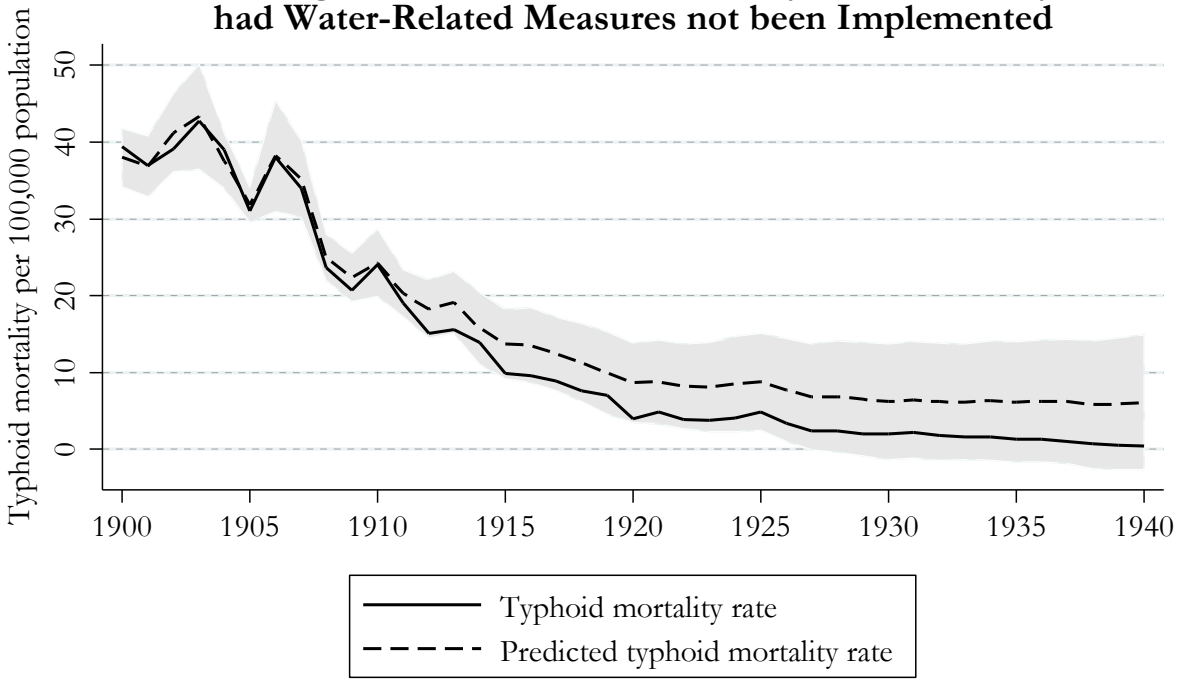
Notes: OLS coefficient estimates (and their 90% confidence intervals) are reported. The dependent variable is equal to the natural log of the number of diarrhea/enteritis deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics and remaining public health interventions listed in Table 5, municipality fixed effects, year fixed effects, and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors are corrected for clustering at the municipal level.

Appendix Figure 8. Actual vs. Predicted Infant Mortality Rates had Water-Related Measures not been Implemented



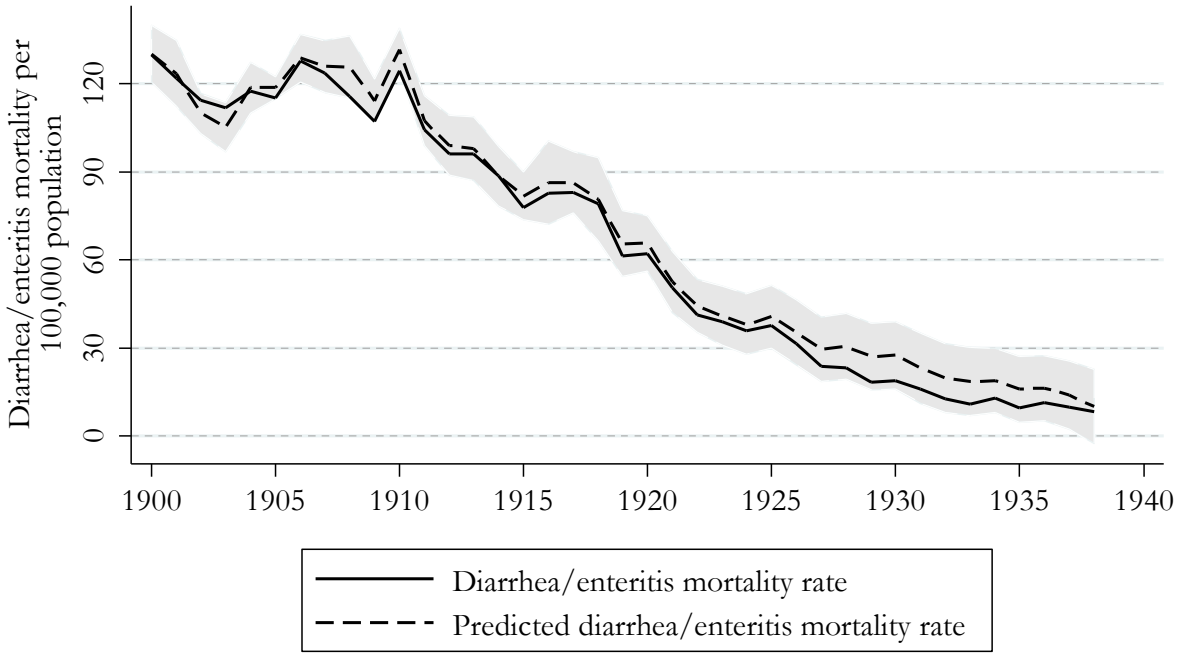
Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1940, published by the U.S. Census Bureau. Predicted infant mortality rates are calculated under the assumption that none of the water-related measures listed in Table 5 were implemented. Shaded area represents 90% confidence region around infant mortality rates.

Appendix Figure 9. Actual vs. Predicted Typhoid Mortality Rates had Water-Related Measures not been Implemented



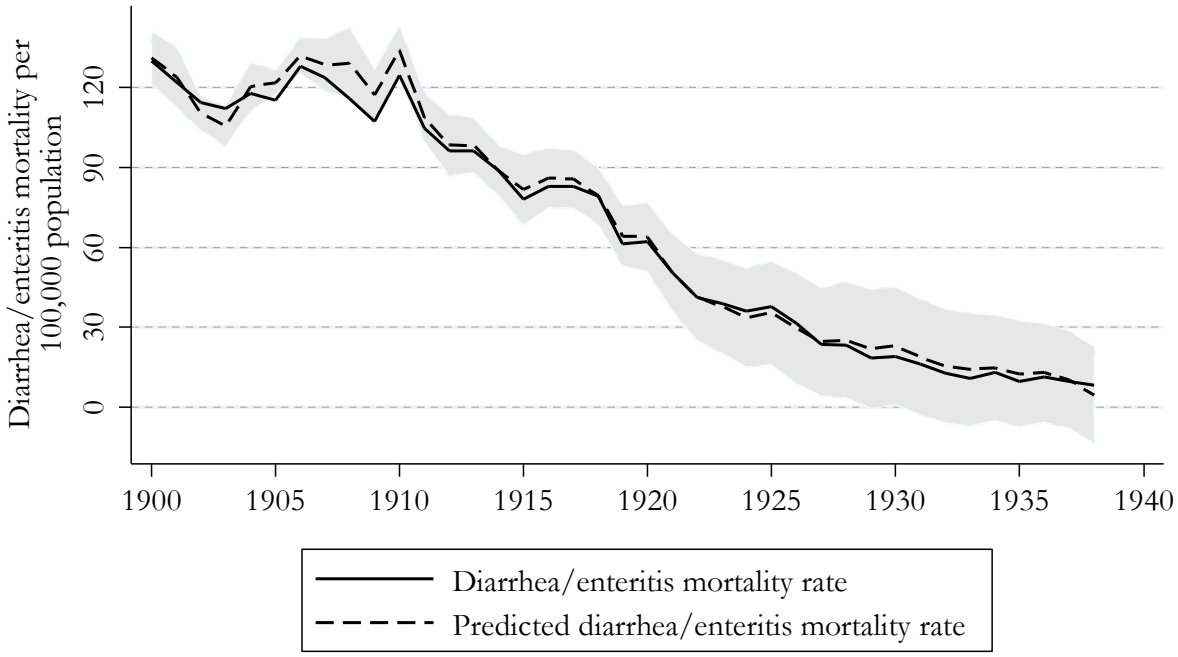
Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1940, published by the U.S. Census Bureau. Predicted typhoid mortality rates are calculated under the assumption that none of the water-related measures listed in Table 5 were implemented. Shaded area represents 90% confidence region around typhoid mortality rates.

Appendix Figure 10. Actual vs. Predicted Diarrhea/Enteritis Mortality Rates
The Effect of Municipal Water Filtration



Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1938, published by the U.S. Census Bureau. Predicted diarrhea/enteritis mortality rates are calculated under the assumption that municipalities did not filter their water supply. Shaded area represents 90% confidence region around diarrhea/enteritis mortality rates.

Appendix Figure 11. Actual vs. Predicted Diarrhea/Enteritis Mortality Rates had Water-Related Measures not been Implemented



Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States* for the period 1900-1938, published by the U.S. Census Bureau. Predicted diarrhea/enteritis mortality rates are calculated under the assumption that none of the water-related measures listed in Table 5 were implemented. Shaded area represents 90% confidence region around diarrhea/enteritis mortality rates.

Appendix Table 1. Robustness Checks: The Effects of Water Quality, Sewage Treatment/Diversion, and Clean Milk on Diarrhea/Enteritis Mortality

	(1)	(2)	(3)	(4)	(5)	(6)
	Control for wages	Control for region-by-year fixed effects	Unweighted	Drop New York City	Drop years 1917-1920	Dependent variable in levels
Water						
Filtration	-.146*	-.164*	-.213***	-.176**	-.161	-8.32
	(.080)	(.093)	(.059)	(.071)	(.094)	(9.96)
Chlorination	.074	-.006	.044	.161**	.099	6.46
	(.066)	(.069)	(.074)	(.071)	(.087)	(6.08)
Clean Water Project	-.131	-.236**	.110	.129	-.121	-22.3*
	(.111)	(.106)	(.126)	(.174)	(.128)	(10.9)
Sewage						
Sewage Treatment/Diversion	.208*	.201**	.146	.267**	.181	14.7
	(.121)	(.097)	(.096)	(.097)	(.113)	(11.0)
Milk						
Bacteriological Standard	.039	.096	.105	.047	.005	-1.53
	(.051)	(.070)	(.067)	(.069)	(.059)	(4.99)
TB Test	.156**	.112**	.093	.217**	.187**	10.7*
	(.073)	(.044)	(.079)	(.079)	(.074)	(5.99)
Joint effect of water-related interventions	.004	-.205*	.087***	.382**	-.001	-9.43*
{*F* statistic}	{1.62}	{2.72}	{4.41}	{3.20}	{1.61}	{2.25}
Joint effect of milk-related interventions	.195**	.208***	.198***	.264***	.191**	9.17
{*F* statistic}	{4.51}	{6.44}	{6.58}	{13.4}	{3.86}	{1.79}
Mean of diarrhea/enteritis mortality rate	67.0	65.5	65.5	65.2	64.8	65.5
N	949	974	974	935	874	974
R^2	.973	.979	.958	.969	.974	.938

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

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1938, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. In columns (1)-(5), the dependent variable is equal to the natural log of the number of diarrhea/enteritis deaths per 100,000 population in municipality *m* and year *t*. In column (6), the dependent variable is equal to the number of diarrhea/enteritis deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics listed in Table 5, municipality fixed effects, year fixed effects and municipality-specific linear trends. In columns (1)-(2) and (4)-(6), regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses.

Appendix Table 2. Diarrhea/Enteritis Mortality and Lags of *Filtration*

	(1)	(2)	(3)
	Diarrhea/Enteritis Mortality		
Year 0	-.074	-.084	-.089
	(.081)	(.080)	(.082)
1 Year After Filtration	-.100	-.111	-.117*
	(.067)	(.067)	(.068)
2 Years After Filtration	-.118	-.132*	-.138*
	(.072)	(.071)	(.070)
3+ Years After Filtration	-.230**	…	…
	(.106)		
3 Years After Filtration	…	-.142	-.149
		(.099)	(.097)
4 Years After Filtration	…	-.196*	-.204*
		(.113)	(.113)
5+ Years After Filtration	…	-.277**	…
		(.113)	
5 Years After Filtration	…	…	-.227*
			(.110)
6 Years After Filtration	…	…	-.277**
			(.109)
7+ Years After Filtration	…	…	-.302**
			(.128)
Mean of dependent variable	65.5	65.5	65.5
N	974	974	974
R^2	.971	.972	.972

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

Notes: Based on annual data from *Mortality Statistics* for the period 1900-1938, 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 number of diarrhea/enteritis deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics and remaining public health interventions listed in Table 5, municipality fixed effects, year fixed effects and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses.

Appendix Table 3. p-Values from Wild Bootstrap

	(1)	(2)	(3)	(4)
	Estimate from Table 7, Column (5)	Estimate from Table 11, Column (1)	Estimate from Table 11, Column (2)	Estimate from Table 11, Column (3)
	Infant Mortality	*Typhoid Mortality*	*Diarrhea/ Enteritis Mortality*	*Diarrhea/ Enteritis* (*Under Age 2*) *Mortality*
Filtration	-.114**	-.171**	-.162*	-.163
	(.045)	(.073)	(.091)	(.105)
		[-4.63]		
p-value from wild cluster bootstrap procedure	.051	.038	.116	.161
Mean of dependent variable	207.8	12.8	65.5	52.0
N	1,024	1,024	974	1,024
R^2	.981	.938	.971	.964

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

Notes: Based on annual data from *Mortality Statistics*, 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 (or, in the case of typhoid, the quartic root) of the number of specified deaths per 100,000 population in municipality *m* and year *t*. Controls include the demographic characteristics and remaining public health interventions listed in Table 5, municipality fixed effects, year fixed effects and municipality-specific linear trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses.

Appendix Table 4. Comparing our Preferred Specification to that of Cutler and Miller (2005)

	C&M Specification	Our Specification
Set of controls	See Appendix Table 5	See Table 5
Model choice	OLS	OLS
Weighting	Unweighted	Weighted by municipality population
Standard errors	Huber-White	Clustered at the municipal level
N	415	1,024
Years	1905-1936	1900-1940
Number of cities	13	25
	City in C&M sample	City in our sample
Baltimore, MD	yes	yes
Boston, MA	…	yes
Buffalo, NY	…	yes
Chicago, IL	yes	yes
Cincinnati, OH	yes	yes
Cleveland, OH	yes	yes
Detroit, MI	yes	yes
Indianapolis, IN	…	yes
Jersey City, NJ	yes	yes
Kansas City, MO	…	yes
Louisville, KY	yes	yes
Memphis, TN	yes	yes
Milwaukee, WI	yes	yes
Minneapolis, MN	…	yes
Newark, NJ	…	yes
New Orleans, LA	yes	yes
New York, NY	…	yes
Philadelphia, PA	yes	yes
Pittsburgh, PA	yes	yes
Providence, RI	…	yes
Rochester, NY	…	yes
San Francisco, CA	…	yes
St. Louis, MO	yes	yes
St. Paul, MN	…	yes
Washington, D.C.	…	yes

Appendix Table 5. List of Controls in Cutler and Miller (2005)

	Description
Filtration	= 1 if municipality had a water filtration plant, = 0 otherwise
Chlorination	= 1 if municipality chemically treated water supply, = 0 otherwise
Filtration w/in 5 Years	= 1 if municipality began filtering water supply within 5 years, = 0 otherwise
Chlorination w/in 5 Years	= 1 if municipality began chemically treating water supply within 5 years, = 0 otherwise
Sewage Treatment[a]	= 1 if municipality had a sewage treatment plant, = 0 otherwise
Sewage Chlorination[b]	= 1 if municipality chemically treated its sewage, = 0 otherwise
Lake Michigan Outfalls	= 1 for Chicago after Lake Michigan sewer outfalls were shut off, = 0 otherwise
Cleveland Intake Tunnel	= 1 for Cleveland after intake tunnel was built to draw water from Lake Erie, = 0 otherwise
$\ln(Mortality)_{t-1}$	One-year lag of natural log of municipal mortality rate
$\ln(Mortality)_{t-2}$	Two-year lag of natural log of municipal mortality rate
$\ln(Mortality)_{t-3}$	Three-year lag of natural log of municipal mortality rate
$\ln(Mortality)_{t-4}$	Four-year lag of natural log of municipal mortality rate
$\ln(Mortality)_{t-5}$	Five-year lag of natural log of municipal mortality rate
ln(*Population*)	Natural log of municipal population
% Female	Percent of municipal population that was female
% Black	Percent of municipal population that was black
% Other Nonwhite	Percent of municipal population that was a nonwhite race other than black
% Foreign	Percent of municipal population that was foreign born
% Under 1	Percent of municipal population that was under 1 years of age
% 1 to 4	Percent of municipal population that was 1 to 4 years of age
% 5 to 9	Percent of municipal population that was 5 to 9 years of age
% 10 to 14	Percent of municipal population that was 10 to 14 years of age
% 15 to 19	Percent of municipal population that was 15 to 19 years of age
% 20 to 24	Percent of municipal population that was 20 to 24 years of age
% 25 to 34	Percent of municipal population that was 25 to 34 years of age
% 35 to 44	Percent of municipal population that was 35 to 44 years of age
% 45 to 64	Percent of municipal population that was 45 to 64 years of age
% 65 and Older	Percent of municipal population that was 65 years of age or older

[a] Three cities in C&M's sample period constructed sewage treatment plants (Baltimore in 1911, Cleveland in 1922 and Milwaukee in 1925).

[b] One city in C&M's sample period chlorinated its sewage (Cleveland in 1922).

Appendix Table 6a. Differences in Recorded Total Mortality Counts between Cutler and Miller (2005) and the U.S. Census Bureau's *Mortality Statistics*

City	Year	C&M's recorded total mortality count[a]	Correct total mortality count from *Mortality Statistics*[b]	Reason for difference (when known)
Baltimore, MD	1910	10729.06	10753	
	1911	10608.85	10407	
	1912	10813.78	10389	
	1913	11280.34	10624	
	1914	11351	10486	
	1915	11053.58	10008	
	1916	11997.81	10668	
	1917	12996.24	11355	
	1929	11647	11629	To calculate, one needs to add white infant mortality (=8,746) and nonwhite infant mortality (=2,883). It appears as if C&M incorrectly transposed the "4" and the "6" for white infant mortality before adding with nonwhite infant mortality.
Chicago, IL	1910	33065.65	33241	
	1911	32378.07	32531	
	1912	34043.64	34034	
	1913	35379.42	35298	
	1914	34070.28	33959	
	1915	35054.38	34894	
	1916	36537.19	36305	
	1917	38620.73	38011	
Cincinnati, OH	1910	6307.244	6319	
	1911	6059.659	6225	
	1912	6198.802	6449	
	1913	6373.602	6735	
	1914	6102.63	6431	
	1915	6043.042	6360	
	1916	6424.347	6741	
	1917	6567.196	6827	
Cleveland, OH	1910	8001.782	8047	
	1911	8071.839	7999	
	1912	8305.11	8156	
	1913	8941.641	8817	
	1914	8383.752	8183	
	1915	9095.276	8808	

	1916	10404.91	9986	
	1917	11360.98	10833	
Detroit, MI	1910	7382.857	7452	
	1911	7478.113	7110	
	1912	8831.332	7782	
	1913	10784.51	8995	
	1914	10575.69	8400	
	1915	11471.23	8720	
	1916	14899.83	10985	
	1917	15820.67	11736	
Jersey City, NJ	1910	4376.58	4401	
	1911	4291.277	4381	
	1912	3834.909	3942	
	1913	4036.024	4194	
	1914	3849.303	4042	
	1915	4096.986	4347	
	1916	4182.075	4480	
	1917	4186.827	4528	
Louisville, KY	1910	3749.809	3756	
	1911	3618.942	3661	
	1912	3702.519	3761	
	1913	3678.877	3784	
	1914	3747.795	3869	
	1915	3434.447	3550	
	1916	3457.839	3586	
	1917	3766.568	3919	
Memphis, TN	1910	2812.165	2818	
	1911	2856.282	2847	
	1912	2964.224	2977	
	1913	2910.776	2923	
	1914	2954.449	2970	
	1915	2950.558	2895	
	1916	0	...	Data for Memphis, TN are not reported in 1916.
	1917	3096.153	3019	
Milwaukee, WI	1910	5172.686	5205	
	1911	4567.123	4727	
	1912	5082.943	5210	
	1913	5058.14	5183	
	1914	4812.378	4959	

	1915	4757.083	4901	
	1916	5387.316	5549	
	1917	5303.467	5461	
New Orleans, LA	1910	7221.468	7250	
	1911	7016.516	7055	
	1912	7004.326	7054	
	1913	7027.57	7088	
	1914	7344.996	7417	
	1915	7685.571	7752	
	1916	6782.515	6847	
	1917	7433.125	7510	
	1930	8003	8030	C&M incorrectly transposed the "0" and "3"
Philadelphia, PA	1910	26937.75	27045	
	1911	26228.93	26276	
	1912	24504.65	24513	
	1913	25689.32	25612	
	1914	26874.71	26739	
	1915	26434.42	26291	
	1916	27895.48	27703	
	1917	30010.18	29649	
Pittsburgh, PA	1910	9574.963	9603	
	1911	8053.422	8099	
	1912	8673.595	8762	
	1913	9433.767	9550	
	1914	8734.226	8857	
	1915	8580.255	8728	
	1916	9901.419	10077	
	1917	10478.07	10645	
St. Louis, MO	1910	10844.5	10888	
	1911	10702.95	10765	
	1912	10560.21	10634	
	1913	10673.76	10761	
	1914	10945.34	11052	
	1915	10173.31	10293	
	1916	11115.76	11263	
	1917	11490.49	11584	

[a] Because the data set provided by Cutler and Miller did not include a variable for the total mortality count, we calculated it based on the provided total mortality rate ("allmort") and population ("pop") variables. Specifically, we used the following command in STATA:

gen mortality = (allmort*pop)/100000.

[b] The total mortality counts for each year listed above can be found in the following *Mortality Statistics* tables:

Year	Location
1910	*Mortality Statistics 1910*, Table 1, pp. 161-180
1911	*Mortality Statistics 1911*, Table 1, pp. 150-173
1912	*Mortality Statistics 1912*, Table 1, pp. 28-49
1913	*Mortality Statistics 1913*, Table 1, pp. 222-243
1914	*Mortality Statistics 1914*, Table 3, pp. 192-219
1915	*Mortality Statistics 1915*, Table 3, pp. 184-211
1916	*Mortality Statistics 1916*, Table 3, pp. 150-175
1917	*Mortality Statistics 1917*, Table 3, pp. 172-197
1929	*Mortality Statistics 1929*, Table 9, pp. 392-424
1930	*Mortality Statistics 1930*, Table 9, pp. 498-542

Appendix Table 6b. Differences in Recorded Infant Mortality Counts between Cutler and Miller (2005) and the U.S. Census Bureau's *Mortality Statistics*

City	Year	C&M's recorded infant mortality count[a]	Correct infant mortality count from *Mortality Statistics*[b]	Reason for difference (when known)
Baltimore, MD	1910	1417.07	2146	
	1911	1295.99	1960	
	1912	1384.03	2022	
	1913	1343	2011	
	1914	1312.43	1949	
	1915	1093.48	1626	
	1916	1158.78	1770	
	1917	1183.75	1780	
Chicago, IL	1910	6595.52	6844	
	1911	6017.86	6252	
	1912	6394.31	6678	
	1913	6649.87	6939	
	1914	6571.52	6878	
	1915	5942.99	6219	
	1916	6566.35	6910	
	1917	6246.72	6664	
	1931	766	2992	To calculate, one needs to add white infant mortality (=2,617) and nonwhite infant mortality (=375). It appears as if C&M incorrectly added mortality for one-year-olds, rather than infants, for whites (=391) and nonwhite infant mortality, which gives their recorded total of 766.
Cincinnati, OH	1910	793.435	917	
	1911	630.712	721	
	1912	693.419	805	
	1913	706.664	801	
	1914	637.264	750	
	1915	524.823	619	
	1916	623.426	736	
	1917	563.757	688	
Cleveland, OH	1924	2366	1386	To calculate, one needs to add white infant mortality (=1,219) and nonwhite infant mortality (=167). It appears as if C&M incorrectly added overall nonwhite mortality (=1,147) and white infant mortality (=1,219), which gives their recorded total of 2,366.
Detroit, MI	1920	2734	2885	C&M incorrectly recorded infant mortality for whites only, which was 2,734. Nonwhite infant mortality was 151.

Jersey City, NJ				No mistakes for Jersey City
Louisville, KY	1910	328.389	503	
	1911	298.928	441	
	1912	46.4965	448	
	1913	322.27	486	
	1914	338.518	496	
	1915	250.146	379	
	1916	283.827	418	
	1917	271.929	397	
Memphis, TN	1910	173.2	345	
	1911	175.645	348	
	1912	185.973	373	
	1913	157.88	319	
	1914	158.831	317	
	1915	118.738	228	
	1916	0	...	Data for Memphis, TN are not reported in 1916.
	1917	158.43	311	
Milwaukee, WI	1926	865	856	C&M incorrectly transposed the "5" and "6"
New Orleans, LA	1910	571.931	1061	
	1911	595.471	1071	
	1912	416.903	774	
	1913	500.74	934	
	1914	477.419	883	
	1915	492.79	927	
	1916	404.008	757	
	1917	446.364	866	
Philadelphia, PA	1910	4557.6	5334	
	1911	4093.3	4769	
	1912	3659.92	4201	
	1913	3925.69	4618	
	1914	4170.24	4870	
	1915	3634.78	4233	
	1916	3669.4	4252	
	1917	3921.49	4637	
Pittsburgh, PA	1901	6578	1580	C&M incorrectly recorded the overall mortality count instead of the infant mortality count.
	1904	771	1771	C&M incorrectly entered "1771" as "771"
	1910	2024.02	2259	
	1911	1648.01	1812	
	1912	1648.71	1811	

	1913	1754.65	1957
	1914	1672.1	1868
	1915	1670.73	1765
	1916	1688.55	1893
	1917	1744.14	1983
	1924	1530	1440
St. Louis, MO	1910	1452.74	1689
	1911	1345.61	1573
	1912	1263.1	1467
	1913	1246.83	1478
	1914	1278.93	1508
	1915	1014.65	1181
	1916	1061.51	1264
	1917	1012.88	1252

[a] In the Cutler and Miller data set, the variable "mort0_1" represents the infant mortality count. Their dependent variable of interest, the natural log of the infant mortality rate, can be recreated with the following STATA command:

gen lninfmrt = ln((mort0_1*100000)/age0_1), where "age0_1" is the municipal infant population.

[b] The infant mortality counts for each year listed above can be found in the following *Mortality Statistics* tables:

Year	Location
1901	*Mortality Statistics 1900 to 1904*, Table 2, pp. 180-197; or Table 8, pp. 270-311
1904	*Mortality Statistics 1900 to 1904*, Table 2, pp. 654-671; or Table 8, pp. 744-785
1910	*Mortality Statistics 1910*, Table 3, pp. 204-251; or Table 9, pp. 455-501; or Table 11, pp. 533-574
1911	*Mortality Statistics 1911*, Table 1, pp. 150-173; or Table 2, pp. 174-257; or Table 7, pp. 466-512; or Table 9, pp. 537-567
1912	*Mortality Statistics 1912*, Table 1, pp. 28-49; or Table 6, pp. 255-301; or Table 8, pp. 335-377
1913	*Mortality Statistics 1913*, Table 1, pp. 222-243; or Table 6, pp. 486-539; or Table 8, pp. 577-625
1914	*Mortality Statistics 1914*, Table 3, pp. 192-219; or Table 4, pp. 220-303; or Table 9, pp. 567-621; or Table 11, pp. 660-709
1915	*Mortality Statistics 1915*, Table 3, pp. 184-211; or Table 4, pp. 212-297; or Table 9, pp. 553-607; or Table 11, pp. 645-694
1916	*Mortality Statistics 1916*, Table 3, pp. 150-175; or Table 9, pp. 406-449; or Table 11, pp. 483-525
1917	*Mortality Statistics 1917*, Table 3, pp. 172-197; or Table 9, pp. 441-487; or Table 11, pp. 523-568
1920	*Mortality Statistics 1920*, Table 3, pp. 140-174; or Table 9, pp. 479-539; or Table 11, pp. 586-646
1924	*Mortality Statistics 1924*, Table 9, pp. 358-390
1926	*Mortality Statistics 1926*, Table 9, pp. 285-317
1931	*Mortality Statistics 1931*, Table 9, pp. 396-440

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