Health and Mortality in the 19th-Century Rural U.S.: The Second Epidemiological Transition in Madison County, NY

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Introduction

Since the mid-19th century, many populations have undergone or are currently experiencing changes in cause-of-death structures characterized by a decline in infectious disease deaths and an increase in deaths from non-communicable diseases. However, this pattern, which is referred to as the second epidemiological transition, does not occur uniformly in all cultural and temporal contexts and may, for example, differ between urban and rural areas. The epidemiological transition remains understudied in rural areas.

We approach the question of how the transition progressed in rural areas of the U.S. through quantitative and qualitative analyses of mortality schedules from Federal and State census records from 1850-1870 for the primarily agriculturally based Madison County in upstate New York.

Background

The Second Epidemiological Transition

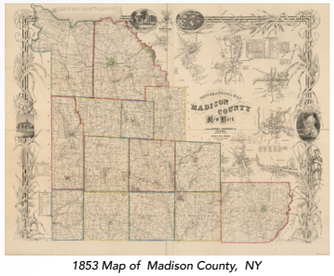
The second epidemiological transition–distinguished from the first that accompanied the adoption and intensification of agriculture–is associated with decreased levels of mortality and increases in life expectancy at birth that occur at later stages of the demographic transition (whereby populations shift in a series of stages from high to low levels of both fertility and mortality). For example, decreases in infectious disease mortality, particularly at younger ages, can produce declines in overall levels of mortality and longer life expectancies, and increase the proportion of people dying from non-communicable causes (at least some of which occur at later adult ages).

While the underlying mechanisms are debated, this transition has been attributed to overall improvements in nutrition, public health measures, and medical interventions, treatments, and education (Gage, 2005). The epidemiological transition model was first developed with respect to observations made at the national level for Western European, relatively wealthy, and industrialized populations (Omran, 1971). As a model, it does not fully capture the nuanced variation in the pace and nature of changes in cause of death and demographic regimes within and between populations. For example, there is evidence that the second epidemiological transition occurs more rapidly in countries with the highest levels of urbanization, and that within populations, it occurs earlier in urban areas than in surrounding rural areas (Budnik, 2014; Harpham & Molyneux, 2001; Schmidt & Sattenspiel, 2017).

Madison County and Commercial Agriculture

Madison County is located in the geographic center of New York State. The area was Haudenosaunee land until the late 1700s, when the federal government and state violated treaties and allowed white settlers to move from New England and the Husdon Valley into central and western New York. Immigrants from Western Europe, mainly Ireland and Wales, soon followed. Black residents, both those escaping enslavement in the South and those formerly enslaved in the North, resided across all the towns from the early 1800s on.

All of the above established and labored on farms, and the area continues to be heavily agricultural today. Around 1850, farmers began transitioning from subsistence-surplus to commercial production, and dairy farming became the primary mode of farming in the 1860s.



1853 Map of Madison County, NY

Methods

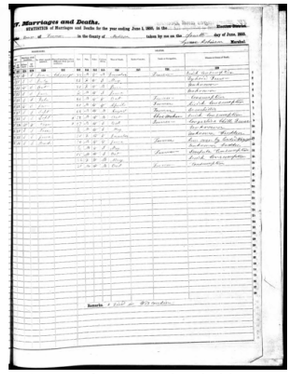
Materials

We use federal and New York State census data, specifically mortality schedules. These recorded deaths in the 12 months prior to the census, and information came from asking household members or local physicians about people who died: their age, sex, race, marital status, place of birth, occupation, days ill, and cause of death.

Methods

Causes of death recorded in the censuses were assigned a corresponding code from the International Classification of Disease, version 11 (ICD-11) when possible. These, along with "unknown" cause for infants, were then sorted into 5 broad categories that we consider to best capture changes in cause of death structure most informative about the second epidemiological transition: infectious disease, non-communicable disease, external causes, neonatal/infant (≤1 year of age) causes (this category includes "unknown cause of death" but excludes specific infectious and non-communicable diseases), and maternal causes. Across all towns, we have age-at-death data for 2336 individuals and cause of death data for 2216 individuals.

Temporal trends in survivorship (which reflects overall mortality levels) were evaluated using Kaplan-Meier survival analysis with a log rank test to identify significant differences in survivorship among the five periods. Temporal variation in proportionate causes of death were assessed using Chi-square tests. We performed these analyses using data pooled from all towns, separately for each town, and for sub-groups of similar towns: those with no village, small village (≤500 people), or large village (> 500 people).



1855 Town of Fenner mortality schedule

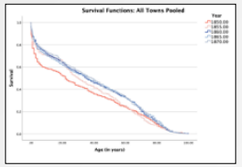
Results

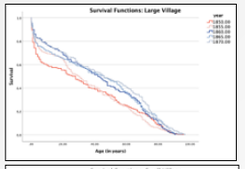
Survivorship

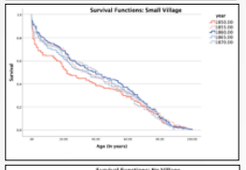
Using the county-level, pooled-town data, Kaplan-Meier analyses reveal significant ($p = 0.002$), substantial, and consistent increases in life expectancy from 1850-1870 (graphs to right).

Town-specific analyses reveal considerable variation in survivorship trends (results not shown), with some towns (e.g., Cazenovia) experiencing trends similar to those observed at the county level while others (e.g., DeRuyter) experienced fluctuations in survivorship over the study period. In Fenner, survivorship was lowest in 1870.

Analysis of the village-size data reveals that for towns with no village and for those with small villages, there was no significant change in survivorship over time; though in both cases survivorship improved in general from 1850 to 1870, there was no consistent pattern across the study period. In contrast, for towns with large villages, there were consistent, significant ($p < 0.001$), and substantial increases in survivorship from 1850-1870.







Cause of Death

Using pooled-town data (tables to right) from 1850-1870, the proportions of deaths from infectious diseases decreased, deaths during infancy declined, and deaths from non-communicable diseases and maternal causes increased. Temporal trends varied across towns.

Analysis of the village-size data reveals that for towns with no village, the proportions of deaths from infectious diseases and non-communicable diseases fluctuated but generally increased over time, while infant deaths decreased substantially. In towns with small villages, the proportions of all causes of death fluctuated. In towns with large villages, the proportions of deaths from infectious diseases fluctuated, the proportion of deaths from non-communicable diseases increased substantially, and deaths during infancy decreased substantially.

Proportionate Causes of Death: All Towns Pooled

Year		Infectious	Non-communicable disease	External cause	Infant	Maternal	Total
1850	Count	284	152	20	48	2	506
	% within COD_Scat	23.0%	20.3%	21.5%	39.7%	11.8%	22.8%
1855	Count	251	149	28	34	5	467
	% within COD_Scat	20.3%	19.9%	30.1%	28.1%	29.4%	21.1%
1860	Count	259	154	12	14	3	442
	% within COD_Scat	20.9%	20.6%	12.9%	11.6%	17.6%	19.9%
1865	Count	209	139	17	13	1	379
	% within COD_Scat	16.9%	18.6%	18.3%	10.7%	5.9%	17.1%
1870	Count	234	154	16	12	6	422
	% within COD_Scat	18.9%	20.6%	17.2%	9.9%	35.3%	19.0%

Proportionate Causes of Death: Large Village

Year		Infectious	Non-communicable disease	External cause	Infant	Maternal	Total
1850	Count	112	64	8	24	1	209
	% within year	53.6%	30.6%	3.8%	11.5%	0.5%	100.0%
1855	Count	92	64	10	14	5	187
	% within year	49.2%	34.2%	5.3%	8.6%	2.7%	100.0%
1860	Count	88	52	4	3	2	149
	% within year	59.1%	34.9%	2.7%	2.0%	1.3%	100.0%
1865	Count	69	60	6	5	1	141
	% within year	48.9%	42.6%	4.3%	3.5%	0.7%	100.0%
1870	Count	101	70	5	4	3	183
	% within year	55.2%	38.3%	2.7%	2.2%	1.6%	100.0%

Proportionate Causes of Death: Small Village

Year		Infectious	Non-communicable disease	External cause	Infant	Maternal	Total
1850	Count	96	57	3	8	1	165
	% within year	58.2%	34.5%	1.8%	4.8%	0.6%	100.0%
1855	Count	87	54	3	4	0	148
	% within year	58.8%	36.5%	2.0%	2.7%	0.0%	100.0%
1860	Count	93	68	4	3	0	168
	% within year	55.4%	40.5%	2.4%	1.8%	0.0%	100.0%
1865	Count	90	46	6	3	0	145
	% within year	62.1%	31.7%	4.1%	2.1%	0.0%	100.0%
1870	Count	69	39	6	7	1	122
	% within year	56.6%	32.0%	4.9%	5.7%	0.8%	100.0%

Proportionate Causes of Death: No Village

Year		Infectious	Non-communicable disease	External cause	Infant	Maternal	Total
1850	Count	12	13	1	6	0	32
	% within year	37.5%	40.6%	3.1%	18.8%	0.0%	100.0%
1855	Count	22	9	1	5	0	37
	% within year	59.5%	24.3%	2.7%	13.5%	0.0%	100.0%
1860	Count	21	12	1	4	1	39
	% within year	53.8%	30.8%	2.6%	10.3%	2.6%	100.0%
1865	Count	16	9	1	0	0	26
	% within year	61.5%	34.6%	3.8%	0.0%	0.0%	100.0%
1870	Count	12	15	1	0	0	28
	% within year	42.9%	53.6%	3.6%	0.0%	0.0%	100.0%

Discussion

At the county level, mean survival times increased by more than 8 years from 1850-1870. For towns with large villages, it increased by nearly 12 years. Such a trend, by itself, has been shown in previous work to be associated with the 2nd epidemiological transition. In England, the initial stages of the transition were associated with improvements in life expectancy, driven first by decreases in adult mortality and then, decades later, by decreases in infant and childhood mortality (Yaussy et al., 2023).

Here, at the scale of the county and in towns with large villages, the demographic trends are accompanied by decreases in deaths during infancy and increases in deaths from non-communicable causes. These changes in cause of death structure align with expectations from the literature. A decrease in mortality during infancy would result in improvements in life expectancy and thus more people exposed to the risk of diseases more common at older ages (e.g. cardiovascular disease). Our analyses also reveal variation across towns with respect to temporal trends in survivorship and proportionate causes of death. This highlights how important local-level contexts are in shaping disease-scapes and population dynamics.

Madison County was heavily agricultural during this time, and during this period, farms transitioned to commercial production and generally made decent money at it, even in more rural towns (Jones et al. 2023). The increase in household income may be a major factor in the overall improvements in survivorship. Groover (2008) found a farm household in similar circumstances in Illinois spent their new money on medicine.

The differences between towns with villages of different sizes may reflect variabilty in household wealth and access to healthcare. Larger villages tended to have more doctors, even when population is taken into account. For more rural towns, getting to a doctor or them to you may have been more difficult. In addition, initial examinations into farm productivity between rural towns and those with larger villages shows relatively wealthier households for the latter. Thus, there may be strong socioeconomic factors behind these differences.

Conclusions

Our findings raise several questions that we will address moving forward. Specifically in future work, we will:

1. Expand the temporal scope of analyses to include all available data through 1880.
2. Examine how risks of mortality at different stages of the life course (particularly infant/juvenile and adult mortality) contribute to the overall pattern of improved survivorship over time.
3. Examine the relationship between the transition to commercial farming and these patterns at household and community levels
4. Compare trends in survivorship and causes of death between urban and rural upstate New York populations.
5. Compare temporospatial trends in survivorship and proportionate causes of death across gender/sex categories.

Acknowledgments and References

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