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RESEARCH ARTICLE

Disease and development—The predicted mortality instrument revisited

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Abstract

This paper revisits Acemoglu-Johnson the predicted mortality instrument. Drawing on a unique historical data set of disease-specific mortality rates, we reconstruct several versions of the instrument that differ in terms of data usage and instrument relevance. Our findings confirm its predictive power on life expectancy. The replication analysis reveals a significant positive second-stage effect of life expectancy on population and total birth rates and a negative effect on GDP per capita for a subset of the revised instruments. Overall, data coverage and empirical tests suggest the superiority of our country-level instrument.

KEYWORDS

growth, life expectancy, predicted mortality instrument

1 | INTRODUCTION

In their seminal study, Acemoglu and Johnson (2007) (**AJ** henceforth) analyze the effect of life expectancy on economic growth using a novel identification strategy that instruments changes in life expectancy at birth (LEB) by initial mortality rates of infectious diseases before the introduction of medical innovations in the 1940s. **AJ** find a significant and positive second-stage effect of LEB on population and the total number of births. The estimated significant and negative effect on GDP per capita challenged preceding findings in the literature on the positive effect of life expectancy on economic performance (e.g., Bloom et al., 1998; Gallup & Sachs, 2001; Lorentzen et al., 2008). The empirical strategy and underlying data have since been widely applied in the literature (Acemoglu et al., 2020; Hansen, 2013; Klasing & Milionis, 2020, among others), and their findings served as the foundation of policy advice (see, e.g., Jamison et al., 2013; Spence & Lewis, 2009).[1] On the other hand, the study has been criticized for not accounting for initial LEB (Acemoglu & Johnson, 2014; Bloom et al., 2014) or the demographic transition (Cervellati & Sunde, 2011). No study so far has, however, replicated the construction of the predicted mortality instrument and investigated the robustness of their results to the used historical data and the implicit assumptions applied in the construction of the instrument.

In this paper, we replicate **AJ** in a *narrow* and in a *wide* sense. We re-digitize mortality rates of infectious diseases and correct discrepancies between published mortality rates in **AJ** and their referenced historical counterparts. In addition, we collect mortality rates from various historical sources to fill gaps in the referenced sources. In total, we revise over 60% of mortality rates for the baseline sample.

Drawing on our rich historical data set, we construct four different predicted mortality instruments. We do so to investigate the sensitivity of the main findings in **AJ** to different assumptions in the construction of the instrument. For the first definition of our predicted mortality rate instrument, we exclusively rely on country-level mortality rates. For the

[1]**AJ** was cited in 1755 studies (*Google Scholar*) and 499 published articles (*Web of Science*) as at the end of 2022, with the number of citations per year peaking in 2022 (Figure S2.1 in Appendix S2.1).

second definition, we supplement country-level rates with town-level rates if no information is available at the country level. Third, country-level rates are replaced whenever town-level information is available to gauge the impact of observed differences between country- and town-level mortality rates on the estimated effects. Fourth, we create an instrument representing the maximum mortality rate for a country based on the available data.

Our *narrow* replication results for the revised predicted mortality instruments vastly confirm the original baseline findings of **AJ**. Irrespective of the construction of the instrument, we find a significant and positive effect of the instrumented change in LEB on population growth and the number of total births, and no impact on total GDP. For GDP per capita, we can replicate the negative second-stage effect of LEB that is significant for the three instruments using town-level information. Importantly, testing for pre-trends reveals that pre-existing trends in LEB are only absent for our *country-level* predicted mortality instrument. This suggests that future work should consider our *country-level* predicted mortality-rate instrument for reliable identification.

Next, we use our detailed historical data to replicate the authors' findings in a *wide* sense by including only countries in the sample that sufficiently recorded disease-specific mortality rates to precisely describe the epidemiological environment. The findings of this *wide* replication confirm previous results.

2 | DATA AND EMPIRICAL FRAMEWORK

2.1 | Data

AJ draw data on mortality rates of 13 infectious diseases for their baseline analysis from two sources: the League of Nations (WHO, 1951, 1952) and the International Vital Statistics (Federal Security Agency, 1947, tab. 20, pp. 174).[2] The 13 infectious diseases under consideration are as follows: typhoid fever, plague, scarlet fever, whooping cough, diphtheria, tuberculosis (all forms), malaria, influenza, smallpox, measles, typhus fever, pneumonia, and cholera. We re-digitize the referenced sources and supplement them by information digitized from the League of Nation's 1937 annual epidemiological report (LNHO, 1939), the United States Biostatistics (USDOC and USCB and USOIAA, 1944a, 1944b, 1944c, 1944d, 1944e, 1944f, 1944g, 1944h, 1944i, 1944j, 1945a, 1945b, 1945c, 1945d, 1945e, 1945f, 1945g, 1945h), and the Korean Vital Statistics 1938–1942 (Government-General of Korea, 1940, 1943, 1944).

We follow the procedure outlined in Appendix C Section F of **AJ** to determine the mortality rate for each country in 1940. In particular, tab. C1 in Appendix C Section F reports the sources and the reference years used for each of the 47 countries in their baseline sample. For their extended sample, the authors state that they "use IVS for Egypt in 1940 ("Health Bureau Areas") and, where relevant, for South Africa, IVS for 1939 ("Europeans"). For all other countries, we use the League of Nations" (**AJ**, Appendix C, p. 12). For sources not covered in **AJ**, we follow the authors' rule for League of Nations data to set the reference year; that is, we "use the information for 1940 or the nearest available year" (Appendix C Section F, p. 12).[3]

In the case that sources exclusively report the number of deaths by disease and not mortality rates, we calculate the corresponding rates using a new historical data set on population size for the period 1930–1946. Crucially, we account for the equivalence of country boundaries referenced in the original documents and our population data set when calculating mortality rates to minimize measurement errors (see Section S3.1 in Appendix S3 for more details).[4] Overall, we revise over 60% of disease-specific mortality rates for countries in the baseline sample of **AJ** (Table S3.3 in Appendix S3).

Comparing digitized mortality rates of referenced sources in **AJ** with the rates published by the authors (both highlighted in bold) reveals unexplained differences (see Tables S3.4 to S3.50 in Section S3.4 of Appendix S3). We identify the following patterns. First, **AJ** use mortality rates in WHO (1951, 1952) instead of the referenced IVS rates in several instances.[5] Second, we identify "clusters" of mortality rates. In particular, mortality rates are identical for multiple countries as in the example of malaria, influenza, and pneumonia for Costa Rica, Guatemala, and Honduras (see Tables S3.14, S3.22, and S3.23).[6] We presume that **AJ** implicitly assume equivalent rates for countries in close proximity to each other

[2]For more details, see **AJ** Appendix C Section F, p. 12.

[3]Since the case is not explicitly discussed in **AJ**, we use the closest year before 1940 for the case of no available data in 1940 and equivalent time differences to 1940 of data points before and after 1940 to safeguard against a potential influence of the epidemiological transition.

[4]We examine the accuracy of our calculated mortality rates by juxtaposing them—if available—against the mortality rates in the source documents.

[5]This appears to be the case except for Chile (Table S3.11), Costa Rica (Table S3.14), Greece (Table S3.21), Guatemala (Table S3.22), Peru (Table S3.39), and Venezuela (Table S3.50).

[6]Nicaragua and Panama also share the same mortality rate for influenza with the three aforementioned countries (see Tables S3.34 and S3.37). Other examples are China and Korea, which have identical rates for influenza, smallpox, and pneumonia (see Tables S3.12 and S3.28). Indonesia and Malaysia exhibit the same rate for malaria and influenza (see Tables S3.25 and S3.29).

due to missing data for particular diseases in their referenced sources. Our new historic data set fills these gaps and provides information on individual mortality rates for each disease and country. Third, comparing the unweighted town-level averages from the rates reported in WHO (1951) with the published mortality rates of **AJ** reveals that their construction prefers town-level averages in 38.7% of cases over available country-level rates in referenced sources (e.g., Australia in Table S3.5 and Italy in Table S3.27). Figure S2.2 in Appendix S2 presents the distribution of mortality rates for each disease in **AJ** (panel A), compared to the distribution of rates at exclusively the country- or town-level (panels B and C) in our data set. Decomposing the distribution of country- and town-level rates reveals that both the relative importance of diseases (measured by the median mortality rate) and absolute rates diverge. Any observed differences could be the result of underreporting, diverging age structures, facilitated transmission of infectious diseases in densely populated cities, or hygienic conditions. Therefore, we believe that there is no clear theoretical argument to a priori prefer either country- or town-level rates but rather view this as an empirical question.

2.2 | Empirical specification

Following **AJ**, we focus on long-run changes in dependent and independent variables in a 2SLS *long-difference* estimation framework with two time periods, 1940 and 1980. The second-stage long-difference regression model can be written as

$$\Delta y_i = \pi \Delta x_i + \Delta \mu + \Delta e_i, \tag{1}$$

where y_{it} denotes changes in log population size, log total births, log GDP, or log GDP per capita, and μ corresponds to a time trend; x_{it} denotes LEB, the endogenous independent variable, which is instrumented by the predicted mortality instrument M_{it}^I.[7] Formally, the corresponding first-stage equation takes the form

$$\Delta x_i = \phi \Delta M_i^I + \Delta \tilde{\mu} + \Delta u_i. \tag{2}$$

In line with **AJ**, standard errors are clustered at the country level with Bangladesh, India, and Pakistan representing one cluster.

Data on outcome variables and independent variables are identical to **AJ** to ensure that any differences in results purely stem from differences in the predicted mortality instrument M_i^I. **AJ** define the predicted mortality instrument as the sum of each country's initial mortality rate in 1940 from infectious diseases until the global medical intervention. Formally, the predicted mortality instrument for country i at time t is

$$M_{it}^I = \sum_{d \in D} [(1 - I_{dt}) M_{di40} + I_{dt} M_{dFt}], \tag{3}$$

where M_{di40} is the mortality in 1940 for country i from disease $d \in D$, with D denoting the set of 13 diseases. I_{dt} is a dummy for intervention for disease d that equals 1 for all dates after the intervention; M_{dFt} is the mortality from disease d at the health frontier of the world at time t which is assumed to be zero (see, **AJ**). In contrast to **AJ**, we assume that the intervention took place during the 1940s for all 13 diseases for the following reasons. First, for most countries, the predicted mortality instrument published by **AJ** is found to be equal to the sum of mortality rates in 1940. However, we observe a discrepancy between the instrument and the sum of mortality rates in 1940 for some countries which we could not trace back to either the omission of dysentery or yellow fever, or baseline intervention dates after the 1940s for cholera, smallpox, and measles.[8] Second, we can address potential concerns about the exact timing of medical innovations during the epidemiological revolution.

Acknowledging the observed differences in country- and town-level mortality rates, we decompose the components of the instrument and go beyond the original version in **AJ** in the following ways. First, we construct a "country-level"

[7]Note that the *long-difference* regression is equivalent to estimating a panel model with two observations per country (1940 and 1980) and country and time fixed effects.

[8]We digitized data on deaths by dysentery and yellow fever from the referenced sources and calculated the corresponding mortality rates for these diseases to investigate if the observed deviations derive from the omission of these diseases. The baseline intervention dates for cholera, measles, and smallpox are the 1950s, 1960s, and 1950s, respectively (see, **AJ**, Appendix B, p. 1). The sum of mortality rates for the 13 infectious diseases in 1940 is presented in parentheses after the published predicted mortality instrument by **AJ** in Tables S3.4 to S3.127 in Sections S3.4 and S3.5 of Appendix S3.

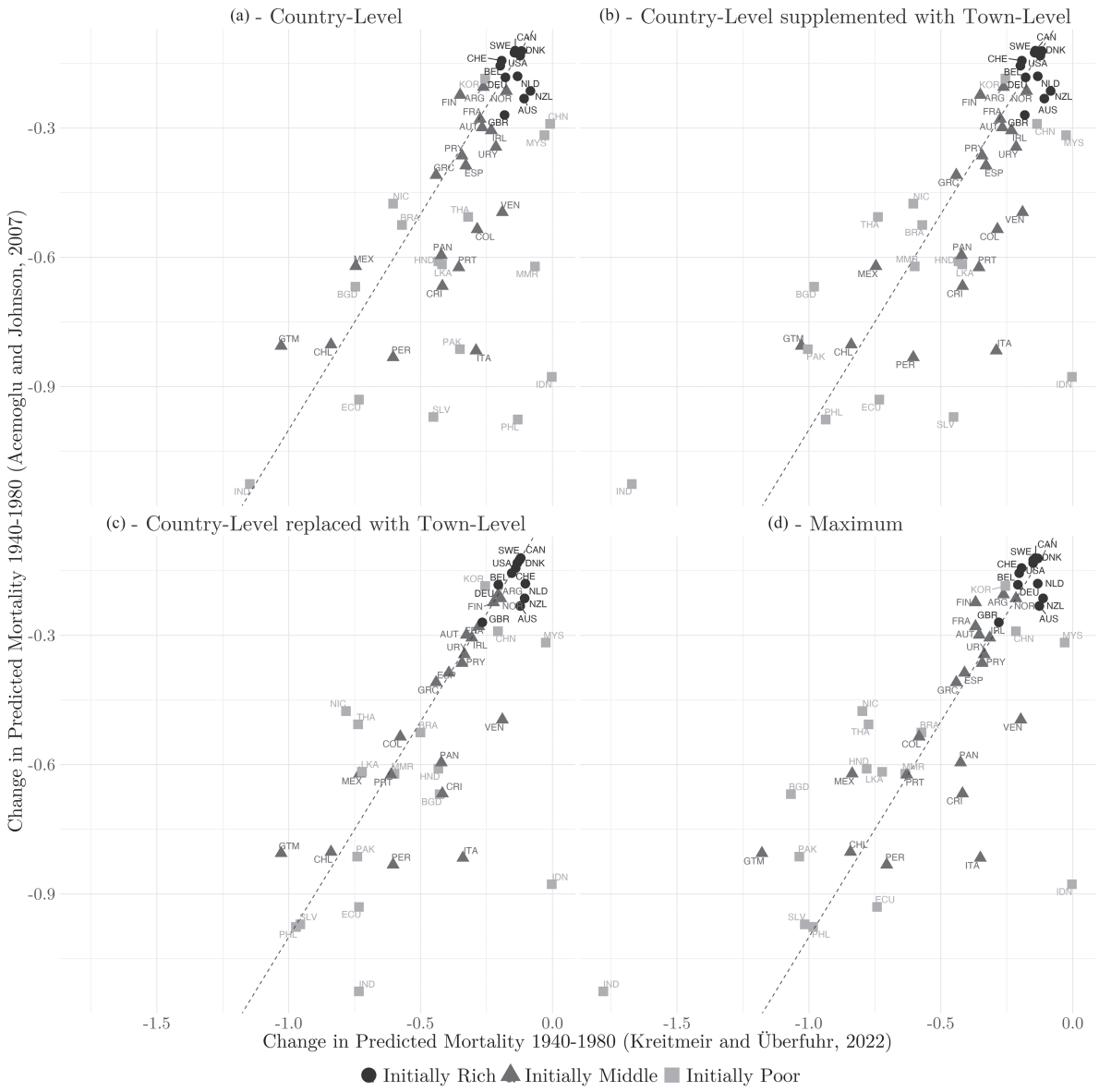

FIGURE 1 Comparison of change in predicted mortality instruments. The sample consists of the 47 baseline countries in **AJ**. Initially rich, initially middle, and initially poor countries are depicted by black circles, gray triangles, and light-gray squares, respectively. The 45° ray (dashed line) is presented.

predicted mortality instrument that relies exclusively on mortality information at the country level.[9] Second, we supplement the *country-level* mortality rates with the average mortality rate across towns for a disease if no country-level value is available. We refer to this instrument as "country-level supplemented with town-level." This version of the instrument can be interpreted as using the "best available data." Third, we treat town-level rates as preferential to country-level data and replace country-level rates with town-level averages whenever the latter are available ("country-level replaced with town-level"). Fourth, the predicted mortality instrument is defined as the sum of the highest available mortality rate of each disease, independent of country or town level.[10] This definition represents the *maximum* exposure of a country to infectious diseases that can be constructed with the available data and, therefore, the maximum predicted benefit of closing the health gap.[11]

[9]Section S3.3 of Appendix S3 provides more details on the construction of the *country-level* instrument.

[10]Descriptive statistics for our four revised predicted mortality instruments and the original instrument of **AJ** are presented in Table S1.1 in Appendix S1.

[11]An equivalently constructed *minimum* predicted mortality instrument possesses inferior predictive power, while estimates remain qualitatively stable. For brevity, we report these results in column 6 in Tables S1.4 and S1.5 in Appendix S1.

Figure 1 compares the four predicted mortality instruments with the original instrument of **AJ** for each country in their baseline sample. We find the largest deviation from the 45°-line for the *country-level* instrument (panel A). In particular, the *country-level* predicted mortality instrument is substantially lower than in **AJ** for several poor and middle-income countries depicted in the bottom right corner below the 45°-line. Supplementing (panel B) and replacing (panel C) *country-level* rates with town-level averages moves the rates gradually closer to the 45°-line. This is consistent with our aforementioned observation of a preference for town- over country-level rates in **AJ**. The similarity of panels C and D suggests that *town-level* rates constitute the maximum for a majority of countries in the baseline sample. This is in line with higher population density facilitating the spread of infectious diseases in urban areas.

3 | REPLICATION AND EXTENSION

3.1 | Narrow replication of Acemoglu and Johnson (2007)

Panel A in Table 1 presents the first-stage relationship between LEB and predicted mortality when estimating Equation (2). Column 1 reports the replicated estimate for the original instrument of **AJ**, and columns 2–5 show the estimated coefficients for our four revised instruments. Irrespective of the revised instrument, coefficient estimates are negative and statistically significant at the 1% level and comparable in magnitude to **AJ**.[12] In particular, the estimated change in predicted mortality for our revised instruments accounts—on average—for about 35.9% to 46.0% of the increase in LEB between 1940 and 1980.[13] Thus, our results confirm the qualitative finding of **AJ** that the international epidemiological transition played a key role in closing the health gap between initially rich versus initially low- and middle-income countries over the period from 1940 to 1980.[14]

Following **AJ**, we conduct a falsification exercise to determine whether changes in predicted mortality are related to pre-existing trends in LEB before the epidemiological transition. Our results reveal a pre-trend in the decade before the epidemiological transition for the original instrument of **AJ** as well as for our three revised instruments, which do not exclusively rely on country-level mortality rates (panel B in Table 1). When we consider the change in LEB over the longer period from 1900 to 1940 (panel C), the significant negative relationship for these instruments vanishes.[15] We conclude that pre-existing trends can only be ruled out for our *country-level* instrument.[16]

Table 2 presents the 2SLS estimates of the effect of LEB on population, total births, total GDP, and GDP per capita. LEB instrumented by our revised predicted mortality instruments has a highly significant and positive effect on population and the total number of births (panels A and B). Our results are qualitatively consistent with **AJ**. Quantitatively, estimated effects are closer to the authors' original estimates once town-level rates are being incorporated in the construction of the instrument. We find support for the overall pattern of economic development reported in **AJ**. We can replicate the insignificant second-stage effect of LEB on total GDP independent of the applied instrument and a significant and negative effect of LEB on GDP per capita for three of our four revised instruments. While the coefficient is imprecisely estimated in the case of our preferred *country-level* instrument, we find no evidence that increases in LEB have a positive effect on income per capita growth.

While the *effective* F-statistic for all revised instruments exceeds the rule-of-thumb cutoff for weak instruments of 10 proposed by Steiger and Stock (1997), we follow the recommendation of Andrews et al. (2019) and additionally report identification-robust Anderson-Rubin 95% confidence intervals in brackets for inference.[17] The Anderson-Rubin 95% con-

[12]Figure S2.3 in Appendix S2 depicts the first-stage relationship for the original, country-level, and country-level replaced with town-level predicted mortality instrument.

[13]For instance, the estimated coefficient of −0.399 for the *country-level* predicted mortality instrument in column 2 corresponds to an average increase in LEB of 13.5% or of 6.7 years.

[14]Reduced-form estimates for the revised instruments presented for the baseline (Table S1.2 and Figure S2.4) and the low- and middle-income country sample (Table S1.6) are also in line with **AJ**.

[15]Figure S2.5 in Appendix S2 graphically illustrates the relationship between the country-level predicted mortality instrument and the change in LEB over different time periods for the baseline and for the low- and middle-income country sample.

[16]Results in Table S1.3 in Appendix S1, moreover, show the absence of a pre-trend in population size or economic output for our preferred *country-level* instrument, while there exists some evidence for a pre-existing positive relationship between economic output and the *maximum*, respectively *country-level supplemented with town-level* instrument (panels B and C). Estimates are qualitatively unchanged for low- and middle-income countries (see Table S1.8).

[17]Note that in the case of only a single instrument, the Anderson-Rubin confidence intervals are "efficient regardless of the strength of the instruments, and so should be reported regardless of the value of the first-stage F" (Andrews et al., 2019, p. 729).

TABLE 1 First stage and falsification exercise.

Predicted mortality rate definition:	(1) Acemoglu and Johnson (2007)	(2) Country-level	(3) Country-level suppl. w. town-level	(4) Country-level repl. w. town-level	(5) Maximum
A. Dependent variable: Change in Ln(LEB), 1940–1980—First stage					
Change in predicted mortality	−0.445***	−0.399***	−0.303***	−0.388***	−0.307***
	(0.064)	(0.065)	(0.059)	(0.085)	(0.056)
	[−0.573, −0.317]	[−0.531, −0.268]	[−0.422, −0.183]	[−0.559, −0.216]	[−0.421, −0.193]
Adjusted R^2	0.493	0.333	0.313	0.358	0.397
Countries	47	47	47	47	47
Number of clusters	45	45	45	45	45
B. Dependent variable: Change in Ln(LEB), 1930–1940—Falsification exercise					
Change in predicted mortality	−0.101***	−0.041	−0.069**	−0.124***	−0.070**
	(0.031)	(0.036)	(0.027)	(0.040)	(0.026)
	[−0.164, −0.038]	[−0.114, 0.032]	[−0.123, −0.015]	[−0.205, −0.043]	[−0.123, −0.016]
Adjusted R^2	0.290	0.012	0.214	0.344	0.243
Countries	33	33	33	33	33
Number of clusters	31	31	31	31	31
C. Dependent variable: Change in Ln(LEB), 1900–1940—Falsification exercise					
Change in predicted mortality	0.135	0.331***	0.103	0.144	0.139*
	(0.106)	(0.103)	(0.084)	(0.133)	(0.082)
	[−0.078, 0.348]	[0.124, 0.537]	[−0.065, 0.272]	[−0.123, 0.412]	[−0.027, 0.306]
Adjusted R^2	0.015	0.169	0.009	0.019	0.045
Countries	47	47	47	47	47
Number of clusters	45	45	45	45	45

Note: Column 1 presents the replicated results for tab. 5 panel A column 2, fig. 6, and tab. 7 panel A column 1 in Acemoglu and Johnson (2007). Robust standard errors (clustered by country) are reported in parentheses. Figures in brackets are 95% confidence intervals based on cluster-robust estimates of the variance matrix.

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

TABLE 2 Narrow replication—2SLS estimates.

Predicted mortality rate definition:	(1) Acemoglu and Johnson (2007)	(2) Country-level	(3) Country-level suppl. w. town-level	(4) Country-level repl. w. town-level	(5) Maximum
A. Dependent variable: Change in Ln(Population)					
Change in Ln(LEB)	1.669***	1.440***	1.666***	1.869***	1.532***
	(0.353)	(0.381)	(0.508)	(0.392)	(0.392)
	[1.057, 2.724]	[0.755, 2.814]	[0.993, ∞]	[1.177, 3.109]	[0.951, 3.607]
Effective *F*-statistic	48.78	37.25	26.02	20.77	29.65
Countries	47	47	47	47	47
Number of clusters	45	45	45	45	45
B. Dependent variable: Change in Ln(Total Births)					
Change in Ln(LEB)	2.529***	2.045***	2.719***	2.613***	2.498***
	(0.494)	(0.438)	(0.533)	(0.580)	(0.427)
	[1.540, 3.819]	[0.914, 3.196]	[1.803, ∞]	[1.461, 4.274]	[1.665, 4.276]
Effective *F*-statistic	51.75	38.64	26.68	20.65	30.15
Countries	45	45	45	45	45
Number of clusters	43	43	43	43	43
C. Dependent variable: Change in Ln(GDP)					
Change in Ln(LEB)	0.315	0.496	−0.142	0.636	−0.162
	(0.588)	(1.048)	(1.005)	(0.529)	(0.832)
	[−0.705, 2.083]	[−1.157, 4.815]	[−1.538, ∞]	[−0.373, 2.185]	[−1.423, 4.168]
Effective *F*-statistic	48.78	37.25	26.02	20.77	29.65
Countries	47	47	47	47	47
Number of clusters	45	45	45	45	45
D. Dependent variable: Change in Ln(GDP per capita)					
Change in Ln(LEB)	−1.316***	−0.865	−1.684***	−1.220***	−1.585***
	(0.390)	(0.670)	(0.562)	(0.452)	(0.491)
	[−2.109, −0.315]	[−1.900, 1.936]	[−2.747, 2.053]	[−2.316, −0.174]	[−2.483, 0.523]
Effective *F*-statistic	48.78	37.25	26.02	20.77	29.65
Countries	47	47	47	47	47
Number of clusters	45	45	45	45	45

Note: Column 1 presents the replicated results for tab. 8 panel A column 1, tab. 8 panel B column 1, tab. 9 panel A column 1, and tab. 9 panel B column 1 in Acemoglu and Johnson (2007). Robust standard errors (clustered by country) are reported in parentheses. The IV estimates were obtained using the Stata command *ivreg2* (Baum et al., 2002). The *effective F-statistic* (Olea & Pflueger, 2013), allowing for errors that are not conditionally homoskedastic and serially uncorrelated, is obtained using the Stata command *weakivtest* (Pflueger & Wang, 2015). The (Anderson-Rubin) 95% confidence intervals presented in brackets are weak-IV-robust ones obtained using the Stata command *weakiv* (Finlay et al., 2013).

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

TABLE 3 Wide replication—2SLS estimates.

Predicted mortality rate definition:	(1) Acemoglu and Johnson (2007)	(2) Country-level	(3) Country-level suppl. w. town-level	(4) Country-level repl. w. town-level	(5) Maximum
A. Dependent variable: Change in Ln(Population)					
Change in Ln(LEB)	1.887***	1.843***	1.769***	2.001***	1.638***
	(0.397)	(0.349)	(0.504)	(0.420)	(0.381)
	[1.229, 3.213]	[1.046, 2.844]	[1.093, ∞]	[1.259, 3.356]	[1.061, 3.594]
Effective *F*-statistic	30.43	33.87	28.28	22.49	34.94
Countries	54	45	54	54	54
Number of clusters	52	45	52	52	52
B. Dependent variable: Change in Ln(Total Births)					
Change in Ln(LEB)	2.614***	2.330***	2.746***	2.669***	2.548***
	(0.504)	(0.507)	(0.486)	(0.540)	(0.397)
	[1.596, 3.940]	[0.941, 3.456]	[1.842, 5.621]	[1.605, 4.097]	[1.741, 3.948]
Effective *F*-statistic	51.62	61.96	32.87	36.32	39.55
Countries	47	40	47	47	47
Number of clusters	45	40	45	45	45
C. Dependent variable: Change in Ln(GDP)					
Change in Ln(LEB)	0.700	1.332**	0.053	0.814*	0.036
	(0.646)	(0.636)	(0.923)	(0.480)	(0.758)
	[−0.329, 2.853]	[0.219, 3.482]	[−1.186, ∞]	[−0.064, 2.196]	[−1.065, 3.839]
Effective *F*-statistic	44.60	48.85	33.45	31.35	38.94
Countries	52	43	52	52	52
Number of clusters	50	43	50	50	50
D. Dependent variable: Change in Ln(GDP per capita)					
Change in Ln(LEB)	−1.144***	−0.510	−1.561***	−1.113***	−1.477***
	(0.411)	(0.493)	(0.530)	(0.403)	(0.457)
	[−1.895, 0.045]	[−1.335, 1.236]	[−2.447, 1.984]	[−2.001, −0.156]	[−2.242, 0.514]
Effective *F*-statistic	44.60	48.85	33.45	31.35	38.94
Countries	52	43	52	52	52
Number of clusters	50	43	50	50	50

Note: To be in the sample, countries need to have non-missing data on disease-specific mortality rates for at least 9 out of the 13 infectious diseases under consideration. Additionally, it is required that pneumonia and tuberculosis (all forms) have non-missing values. Robust standard errors (clustered by country) are reported in parentheses. The IV estimates were obtained using the Stata command *ivreg2* (Baum et al., 2002). The *effective F-statistic* (Olea & Pflueger, 2013), allowing for errors that are not conditionally homoskedastic and serially uncorrelated, is obtained using the Stata command *weakivtest* (Pflueger & Wang, 2015). The (Anderson-Rubin) 95% confidence intervals presented in brackets are weak-IV-robust ones obtained using the Stata command *weakiv* (Finlay et al., 2013).

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

fidence intervals in panel D indicate that the estimated relationship is only robust to weak instruments for specifications with the *country-level replaced with town-level* predicted mortality instrument.

Estimates are qualitatively stable when we estimate the *long-difference* regressions for the period from 1940 to 2000 (Table S1.9 in Appendix S1),[18] restrict the sample for both time periods to low- and middle-income countries (Tables S1.7 and S1.10 in Appendix S1), or use the *average* over time instead of the reference year mortality rate in the construction of the predicted mortality instrument to account for potential outliers due to, for example, virus strains or climatic conditions (Table S1.5 in Appendix S1).[19]

3.2 | Wide replication of Acemoglu and Johnson (2007)

Drawing on our rich data set on historical mortality rates, we replicate the main findings of **AJ** for a new, "homogeneous" sample of countries with "comparable" information on mortality rates in 1940. In particular, for this analysis, we require that countries have non-missing mortality rates for *(i)* at least nine out of the 13 infectious diseases under consideration *and (i)* for pneumonia and tuberculosis (all forms)—the two major causes of death among the 13 infectious diseases in the 1940s (see Figure S2.2 in Appendix S2).[20] Consequently, we are able to address concerns that previous findings are the result of measurement error introduced mechanically by treating missing mortality rates as zero values in the construction of the instrument.

Table 3 reports the 2SLS estimates of LEB on demographic and economic outcome variables in **AJ** for the *homogeneous* country sample.[21] Panels A and B confirm the highly significant and positive effect of LEB on population growth and total births for all four revised predicted mortality instruments. With the exception of our *country-level* instrument, the second-stage effect on GDP remains indistinguishable from zero while a significant and negative impact on GDP per capita is detected. Coefficient estimates for GDP per capita are, however, only robust to weak instruments in the case of our *country-level replaced with town-level* instrument.

4 | CONCLUSION

This paper replicates the seminal study of **AJ** on the effect of LEB on economic development using a new historical data set. In particular, our data set on historic mortality rates before the epidemiological transition in the 1940s addresses discrepancies in the original data of **AJ** and provides a unique detailed and extensive coverage of diseases by country. Using four revised predicted mortality instruments, we replicate the baseline results of **AJ** that increased LEB led to a significant increase in population size and total births. Moreover, we find no evidence for LEB having a positive effect on income per capita. Restricting the sample to countries with sufficient information on mortality rates to accurately picture the epidemiological situation in 1940 confirms our narrow replication findings.

Notably, our analysis uncovers a pre-existing trend in the decade before the epidemiological transition for the original instrument of **AJ** and for the three revised instruments that are not exclusively based on country-level information. In conjunction with a coverage of at least 53 countries even when applying conservative sample selection criteria, future research should thus consider the use of our new and more relevant *country-level* predicted mortality instrument.

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[18] As discussed in **AJ**, results for the period 1940–2000 should be interpreted with caution due to the impact of HIV after 1980.

[19] Table S1.4 in Appendix S1 reports the corresponding first-stage and falsification exercise estimates for the *average* mortality rate instruments.

[20] Note that countries in our sample that fulfill the aforementioned requirements only have missing values for the four diseases with the lowest median mortality rate (smallpox, plague, typhus fever, and scarlet fever) or cholera, which is only available in LoN V2.

[21] Tables reporting first-stage, reduced-form, and falsification estimates can be found in Section S1.5. Results for a more restrictive sample cutoff—that is, when we require countries to have at least 10 non-missing values in addition to non-missing values for pneumonia and tuberculosis (all forms)—can be found in Section S1.6.

OPEN RESEARCH BADGES

This article has been awarded Open Data Badge for making publicly available the digitally-shareable data necessary to reproduce the reported results. Data is available at https://doi.org/10.15456/jae.2023321.1041806336.

DATA AVAILABILITY STATEMENT

Data and replication codes are available at https://doi.org/10.15456/jae.2023321.1041806336.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of the article.

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