The International Epidemiological Transition and the Education Gender Gap
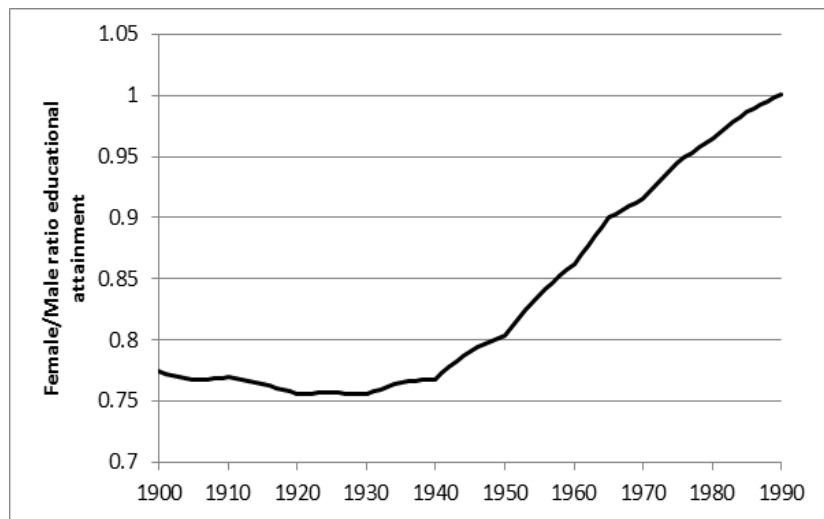
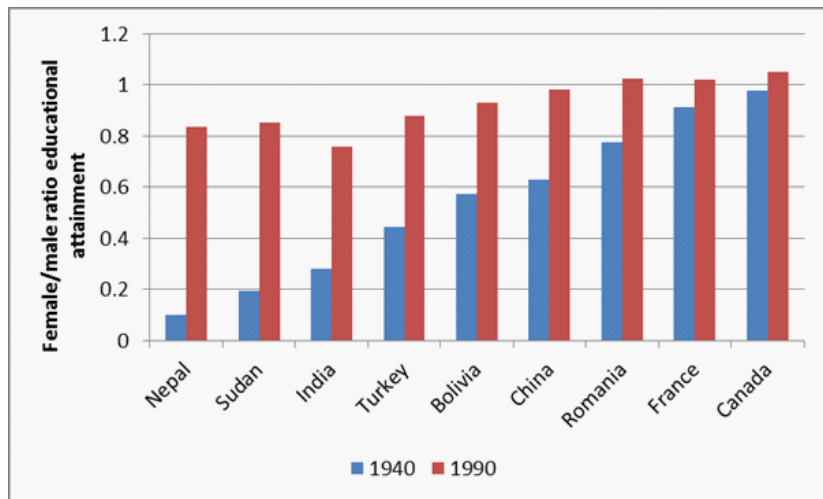**Mariko J. Klasing   Petros Milionis**

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Female/Male Average Years of Schooling: Global Average

Female/Male Average Years of Schooling: Selected Countries

Question and Related Literature

What can explain the relative rise in female educational attainment?

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Existing explanations for the rise in female schooling:

- Improved labor market opportunities for women (Goldin, 2006; Goldin et al., 2006)
- Decline in the price of household durables (Greenwood et al., 2005)
- Cultural change (Fernandez, 2013; Fernandez et al., 2004)
- Introduction of the birth control pill (Goldin & Katz, 2002)
- Improvements in maternal health (Jayachandran and Lleras-Muney, 2009; Albanesi and Olivetti, 2015).

Focus of this literature is mostly on individual countries, particularly the U.S.

Question and Related Literature

Broader literature on the effect of improvements in life expectancy and health on educational attainment.

- Key mechanisms:
  - Expansion of the time horizon over which the education investments can be reaped off (Ben-Porath, 1965).
  - Substitution of parental resources from from child quantity to child quality (Kalemli-Ozcan, 2002, 2003).
- Macroeconomic Implications: Boucekkine et al. (2002, 2003) Cervellati & Sunde (2005, 2013) de la Croix & Licandro (2012).
- Microeconomic Evidence: Bleakley and Lange (2006) Bleakley, (2007) Jayachandran & Lleiras-Muney (2009) Oster et al. (2013)

Gender differences are not considered in this literature.

Our Contribution

- Explore how differential health improvements for males and females during the 20th century affected the education gender gap.

- Identify the impact of differential health improvements on education by exploiting variation in the distribution of infectious diseases across countries prior to the onset International Epidemiological Transition, as in Acemoglu and Johnson (2007).

- Demonstrate that the global reductions in the education gender gap were the result of relatively stronger improvements in female health compared to male health.

The International Epidemiological Transition (IET)

- Global spread of western medical technologies (vaccines, antibiotics) over the 2nd half of the 20th century.

- Driven by the coordinated efforts of UN and WHO.

- Led to sharp global reductions in mortality from highly fatal infectious diseases.

- Acemoglu and Johnson (2007), Cervellati and Sunde (2011), Hansen (2013) have assessed the impact of the IET on GDP, population, and education.

- We explore a less well-known aspect of the IET:

  The gender-specific nature of the mortality reductions.

Gender Differences in Medical Treatments

- Men and women can respond differently to the same medical treatment.

- Medical studies have documented that women exhibit stronger immune responses to vaccines than men, leading to higher levels of vaccine efficacy (Fish, 2008; Klein et al. 2010; Furman et al., 2013).

- Both hormones (testosteron vs. estrogen) and chromosomes (XX vs. XY) seem to play a role.

- However, no such gender differences have been documented for antiviral and antibacterial drugs.

Vaccination is expected to have larger impacts on female than male life expectancy.

Exogenous Variation in Health Improvements

- Before the onset of IET, the prevalence of infectious diseases varied across countries.

- Following the IET (after 1940), most of these diseases were eradicated.

- Countries with higher initial disease burden experienced larger reductions in mortality and larger increases in life expectancy.

- Mortality reductions were driven by global health interventions, therefore were independent of other time-varying countries' characteristics correlated with educational attainment.

- Instrument for the actual life expectancy increases: Difference between initial mortality rate and zero (predicted mortality change).

Variation in Health Improvements across Gender

- Classify diseases as vaccine-preventable *(V-disease group)* and not vaccine-preventable (*NV-disease group*).

- Countries with higher initial mortality rates from diseases of the *V-disease group* are expected to experience relatively larger gains in female life expectancy than countries with high initial mortality from diseases of the *NV-disease group*.

- Use differences in the initial mortality rates from the two groups of diseases as an exogenous source of variation in the differential life expectancy increases of females and males.

Empirical Specification

IV-estimation of the effect of changes in life expectancy on education across countries and gender.

Estimation in long differences: Two observations (1940, 1980) for each gender group (female, male) in each country.

First-stage regression:

$$LE_{gct} = \beta_V \sum_{d \in V} M_{dct} + \beta_{Vf} \cdot I_{fem} \cdot \sum_{d \in V} M_{dct}$$

$$+ \beta_{NV} \sum_{d \in NV} M_{dct} + \beta_{NVf} \cdot I_{fem} \cdot \sum_{d \in NV} M_{dct}$$

$$+ \delta_{gc} + \delta_t + \varepsilon_{gct}, \text{ with } M_{dc80} = 0.$$

Second-stage regression:

$$Edu_{gct} = \alpha \cdot \widehat{LE}_{gct} + \gamma_{gc} + \gamma_t + u_{gct}$$

Data

- Panel data for 75 countries ($75 \cdot 2 \cdot 2 = 300$ observations)

- Life expectancy at birth: UN Demographic Yearbook.

- Educational attainment: Barro and Lee (2013).

- Mortality rates from 13 infectious diseases in 1940: Acemoglu and Johnson (2007).

	1940	1980
Life expectancy gap (F-M)	2.8	5.6
Education gap (F-M)	-0.28	0.02

Coding of Diseases

Diseases are classified based on information from the Cambridge Historical Dictionary of Diseases.

V-Disease Group: *diphtheria, influenza, measles, pneumonia, smallpox, tuberculosis, whooping cough.*

  Diseases for which new/improved vaccines became available after 1940.

NV-Disease Group: *cholera, malaria, plague, scarlet fever, typhoid fever, typhus.*

Diseases for which effective vaccines don't exist or were already available and widely used before 1940.

Baseline Results

	(1)	(2)	(3)
Panel A: 1st stage results	**Dependent Variable: Life expectancy at birth**		
Mortality, overall	-15.39***	-12.938***	
	[2.108]	[2.167]	
Female x Mortality, overall		-4.900**	
		[2.154]	
Mortality, V			
Female x Mortality, V			
Mortality, NV			
Female x Mortality, NV			
Panel B: 2nd stage results	**Dependent Variable: Years of schooling**		
Life expectancy			
Female x LE			
Observations			
Number of countries			
1st stage F-statistic			

Notes : All regressions include country-sex and year fixed effects. Heteroskedasticity robust standard errors clustered at the country-sex level are reported in brackets.
*** p<0.01, ** p<0.05, * p<0.1.

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Female x Mortality, V			-4.959**
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Mortality, NV			-18.534***
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Female x Mortality, NV			-5.618
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Panel B: 2nd stage results	**Dependent Variable: Years of schooling**		
Life expectancy	0.117***	0.115***	0.114***
	[0.0444]	[0.0426]	[0.0415]
Female x LE			
Observations	300	300	300
Number of countries	75	75	75
1st stage F-statistic	77.35	43.94	22.64

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Baseline Results: Magnitudes

- Predicted changes in life expectancy:

  - Men: 5.6 years. Women: 7.8 years.

  - Corresponds to 35% of the actual life expectancy changes.

- Predicted changes in average years of schooling:

  - Men: 0.65 years. Women: 0.89 years

  - Reduction by 0.24 years corresponds to 80% of the actual reductions in the gender gap.

Robustness Checks

Results are robust to:

- Alternative assumptions regarding disease mortality in 1980.

- Analyzing sub-sets of diseases.

- Controlling for the type of causative agent behind the diseases (bacteria, viruses, parasites).

- Excluding countries actively involved in drug development.

- Eliminating countries where data quality may be questionable.

- Using alternative measures of educational attainment.

Robustness Checks

Results are robust to controlling for:

- Key correlates of countries' health and educational attainment (GDP per capita, fertility).

- Differences in socio-economic status and power between males and females (age difference at marriage, voting rights).

- Labor market conditions.

- Other sources of mortality differences between males and females (maternal mortality, cancer/cardio-vascular diseases).

- Underlying time trends in the schooling data.

Implications for Economic Development

- The IET resulted in large gains in life expectancy (health) around the world.

- The health of females improved relatively more due to their stronger immune response to vaccination.

- This resulted in sizeable gains in relative female educational attainment and a reduction in the education gender gap.

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Did these differential health improvements also have macroeconomic effects beyond the effects on educational attainment?

Positive and Negative Effects of Health Improvements

- Health improvements are expected to influence economic development through three channels:
    1. Increase in labor productivity and human capital accumulation.
    2. Increase in labor force participation and reduction in fertility.
    3. Acceleration of population growth.

- Acemoglu and Johnson (2007): IET had predominantly a negative effect on GDP per capita.

- Cervellati and Sunde (2011): Effect varies across countries; positive effect in post-demographic transition countries.

Gender-Specific Effects on Economic Development

- Explore the differential effects of increases in male and female health on economic development.

- De la Croix and Vander Donckt (2010) and Bloom et al. (2015):
  - Male health improvements have primarily an income effect: Increase in net fertility and reduction in GDP per capita.
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  - Female health improvements have also a substitution effect: Reduction in fertility, increase in labor force participation and increase in GDP per capita.

- Female health improvements are expected to contribute to larger increases in per capita GDP than male health improvements.

- Simple reduced-form test: Relate predicted mortality changes (related to the countries' initial disease environment) to changes in per capita GDP.

Health Effects on Economics Development

Dependent Variable:	Log GDP per capita				
	(1)	(2)	(3)	(4)	(5)
Life expectancy at birth	-0.013**				
	[0.0063]				
Mortality, overall		0.530***	0.404***		
		[0.153]	[0.144]		
Mortality x post, overall			-0.941***		
			[0.197]		
Mortality, V				0.213	0.216
				[0.235]	[0.212]
Mortality x post, V					-0.933***
					[0.297]
Mortality, NV				2.082**	1.329*
				[0.962]	[0.753]
Mortality x post, NV					3.264
					[13.864]
Observations	138	138	138	138	138
Number of countries	69	69	69	69	69
Within R-squared	0.85	0.87	0.89	0.87	0.89

Notes: All regressions include country and year fixed effects. Heteroskedasticity robust standard errors clustered at the country level are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Concluding Remarks

- Global spread of post-1940 western medical technologies affected educational attainment of male and females and economic development in more general.

- Females gained more in terms of life expectancy than males (7.8 vs. 5.6 years). Driven by gender differences in the immune response to vaccines.

- Relative increases in female life expectancy resulted in sizeable gains in female education and a reduction in the education gender gap: Estimates can account for 80% of the observed reduction in the education gender gap.

- Differential health improvements had also broader implications for economic development: Female health improvements have a larger economic dividend.