The Gendered Impact of Young Children's Health on Human Capital: Evidence from Turkey

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Abstract

This paper investigates the impact of the 1985 Turkish Immunization Campaign, a nationwide campaign which vaccinated children from 0 to 60 months against measles, polio, tetanus, diphtheria and pertussis on health and human capital. I find that children age-eligible for the vaccination campaign were less likely to be disabled and illiterate and more likely to complete primary school. I find similar but smaller gains on human capital for middle-school age children who had an age eligible child in their household; furthermore, these spillover effects accrue mainly to older girl siblings. My results are interpreted within a model of intrahousehold allocation in which older children of different genders must divide their time between childcare and schooling. The findings lend support to the view that girls' human capital accumulation is particularly sensitive to the health of younger children in the household and offers another policy lever for increasing girls' educational attainment in the developing world.

JEL Codes: I25, O15

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1 Introduction

How technologies are introduced and their interplay with existing cultural norms can have important, unanticipated consequences for development. This paper explores one such technology– immunizations, which has revolutionized the control of infectious disease in recent history. The target of most immunization campaigns are young children, and like other early childhood interventions, such campaigns may have important effects on other household members.[1] The spillover effects on non-treated children are unclear, and depend on parental preferences and household budget constraints. The handful of empirical studies which have investigated such spillover effects focus on whether parents offset investments in treated children out of a desire for equity or divert complementary investments to the treated child.[2] However, early child interventions operate within a cultural context of gender roles that typically place the burden of household activities on girls.[3] Evidence on the existence of such gender norms is presented in Figure 1 which demonstrates that, for Turkish children 11 to 15 years of age, the gap in within school enrollment for boys versus girls increases in the number of illness episodes experienced by younger children in the household.[4]

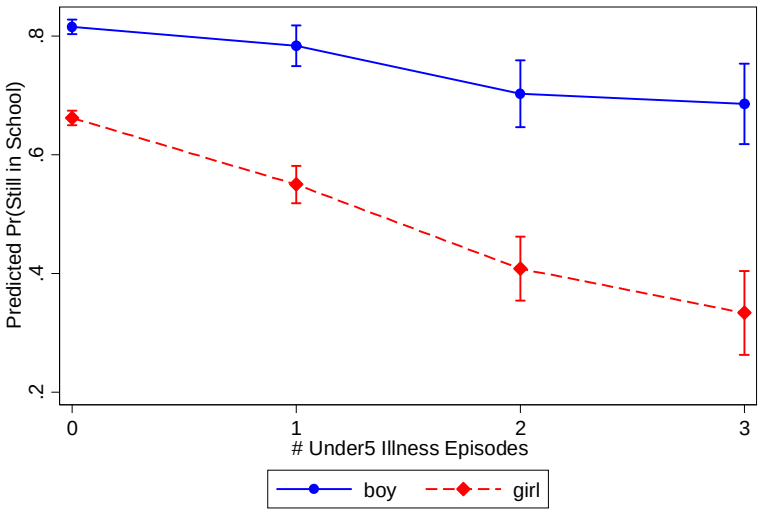
[1] A large body of research in the biomedical and social sciences documents the importance of in utero and early childhood health for later health and socio-economic outcomes (for a comprehensive review see **??**).

[2] **?** uses the shock of the Spanish Flu and finds that siblings of children who were in utero at the time of flu received more parental educational investments. In a similar vein, **?** demonstrate that children who had higher program exposure to in utero iodine were likely to be breastfed longer and more likely to receive vaccines. In addition, **?** develop a measure of sibling exposure to iodine and finds that this measure has explanatory power for immunizations above and beyond a child's own program exposure. This paper builds on these studies by; 1) investigating an exposure that was outside of the in utero period (early childhood immunization) and; 2) assessing its impact on non-health (e.g. education) outcomes of older siblings; 3) demonstrating how such outcomes may vary by gender; and 4) exploiting an intervention that could not directly be obtained by the older siblings of a given index younger child. In this regard, the paper is most similar to **?** who finds that ten years after the Kremer and Miguel deworming experiment, large cognitive effects are found – comparable to between 0.5 and 0.8 years of schooling – for children who were less than one year old (including those who were not yet conceived) when their communities received mass deworming treatment through school-based distribution methods. In contrast to the current analysis, the deworming treatment is on older children and spillovers are assessed on the population in utero or not conceived at the time of the experiment. The findings suggest that young and unborn/not yet conceived children who had a higher fraction of girls in their household who could have attended primary school where the deworming was given had more of a benefit from the program. Ozier's results are consistent with the time use model and findings presented herein. **?** investigated the impact of vaccinations on human capital in the Phillipines. Simlar to this study, they found no effect of vaccinations on height, but did find that vaccination increased test scores by 0.5 standard deviation. Their study did not specifically investigate spillover effects.

[3] In the United Nations Report "Legislative Reform on Child Domestic Labour: A Gender Analysis" it is estimated that 350 million children ages 5-17 are engaged in work, a large percentage in domestic service (**?**, page i). In addition, "Traditional gender roles have contributed to the assumption that women and girls make ideal domestic workers because they are subservient and meek. They are also expected to be well skilled at care giving, child rearing and house keeping, all activities considered to be an extension of the woman's natural role (**?**, page 3)." See work by **?** for a discussion of similar issues in historical US.

[4] Results are similar when aggregating over Demographic and Health surveys around the world, when conditioning on household fixed effects or number of children under 5 (Alsan and Bendavid, 2015).

FIGURE 1: GENDERED SCHOOLING RESPONSE TO CHILD ILLNESS



Notes: Data presented are from the Turkish Demographic and Health Surveys (1993 1998 and 2003) merging in the women's file which includes questions on illness episodes experienced by under 5 children in the last two weeks with the household file which includes information on whether a member is "still in school" which is used as a binary indicator for enrollment.

This paper investigates the impact of one of the most successful and largest mass vaccination campaigns in recent history–the Turkish National Immunization Campaign of 1985–on the health and human capital of age-eligible recipients and their older siblings. The impetus for the campaign grew out of a long-standing personal relationship between the UNICEF director and the prime minister of Turkey with the stated goal of improving child survival. The campaign was unique in its sheer scale and the number of diseases that were included in the effort (measles, polio, as well as diphtheria pertussis and tetanus (DPT)).[5] The logistical success of the campaign was impressive. Within three months 27 million vaccines had been administered; coverage for measles vaccine increased from 37 to 83 percent nationwide and a similarly impressive jump was noted for DPT vaccination. As shown below, the gains in vaccination were greatest for areas with the lowest coverage in the prevaccination period. The empirical strategy adopted exploits heterogeneity in the precampaign prevalence of vaccine preventable illness to compare areas that experienced a relatively larger gain in coverage to areas that experienced a more modest increase. The strategy developed in the paper corrects for underreporting of vital events which is particularly severe in rural areas and presents an obstacle to impact evaluation in developing countries. The greatest threat to the validity of the analysis is that vaccine preventable disease (VPD) prevalence is not randomly assigned. High VPD prevalence in the precampaign period could be correlated with low literacy and socioeconomic status more generally–and such areas could be on a different time path than areas with less prevalent disease. I provide evidence that VPD prevalence is not correlated with precampaign covariates prior to the rollout of the intervention conditional on other covariates.

[5] Other mass vaccination campaigns include Brazil (1980 to 1985), India (1985) and Burkina Faso (late 1984). However, the Brazil campaign only included polio vaccination; the India campaign was instituted by private doctors, and the Burkina Faso campaign also had a primary health care component. The Turkish campaign is therefore unique in its scale, number of different types of vaccines delivered, use of the public sector and exclusive focus on child health not on other health domains (**?**).

Second, a falsification test using a placebo intervention date for the campaign fails to produce similar results.

The campaign did not achieve its stated goal of reducing infant or child mortality. Reasons for the null effect are discussed, with the most likely one being that vaccine preventable illnesses were not a leading cause of mortality for this age group at the time.[6] However, there were declines in morbidity and gains in literacy and primary school completion for age-eligible children. A one standard deviation increase of vaccine preventable illness in the precampaign period was associated with approximately a 0.6 percentage point decline in disability and a 2 percentage point increase in literacy and primary school completion. These findings are robust to a range of controls thought to influence children's health and education at the individual, household and local geographic level such as maternal literacy, father's occupation and health care infrastructure. The results also are not driven by mean reversion or a specific geographic subsample of the country.[7] The effect of the campaign on morbidity (disability) for age-eligible children is similar for boys and girls, though the effect on human capital accumulation is larger for girls than boys–suggesting there may be other, non-health related gains that girls differentially obtain from the program.[8]

I test for gender-specific spillover impacts of the immunization campaign by examining the human capital benefits experienced by household members living with an age eligible child.[9] I find older girls are positively affected by living with a child who was age-eligible for the intervention and the magnitude of the spillover effect can account for the majority of the human capital gains accruing to girls in the analysis of age-eligible children. I show that the gendered spillover impact is increasing in the number of young children in the household and is greater if the mother works outside the home.

These results are interpreted within a model of intrahousehold allocation of scarce time resources. In an environment where parents seek to maximize the expected earnings of their children, and the youngest children require inputs of time to survive, parents must choose how much time an older sibling may spend in school and how much time she spends performing childcare and other household activities. If girls are perceived as more appropriate caregivers, given proscribed gender norms or separate spheres, they are predicted to obtain lower amounts of schooling and their human capital accumulation will be more sensitive to the health of younger children than their male peers. The model and the paper focuses on a time use channel. Of course, less illness in the household would also lower medical expenditures and potentially increase household income. Thus, even though primary schooling at this time in Turkey was considered mandatory, if parents

[6] Results on mortality might be more impressive for the rollout of pneumococcal and rotavirus vaccination (since pneumonia and diarrhea are the leading causes of child mortality in developing countries). More recent research suggests the measles virus suppresses the immune system by attacking memory B cells and could leave a long lasting impact on the ability of individuals to fight many different types of infections(**?**).

[7] Results with region-year fixed effects and mean reversion are reported in Table 6.

[8] Findings by **?** and **?** also demonstrate girls might not be vaccinated as consistently as boys.

[9] I use the term "spillover" to refer to gains that are not directly related to receipt of the vaccine. Although the older age children might also benefit from "herd immunity" –and this might be larger for girls than boys if they are tasked with childcare, this does not appear to be the main explanation for my findings. This is because the age-specific complication rate of measles (which is the most prevalent and well documented of all vaccine preventable illnesses) demonstrates a stark U-shaped pattern, with infants and young toddlers having the highest complication rate (41.4%) compared to those in the 10-19 year old range (12.8%) or older adults (34.4%) (**?**). Second, measles is so highly contagious that most middle school age children would have already been naturally exposed, and exposure confers lifelong immunity (CDC, 2015).

demand for their son's education is less income elastic than for their daughters, this could also be an alternative mechanism driving the results. I argue this mechanism is less important since the income shock to the household from reduced morbidity of an under-five child is small. This is because: a) mothers and older girls, the caregivers of sick children, are generally not engaged in remunerated activities (the shadow wage of their time is low) nor are the young children they are tending;[10] and b) most illness episodes of children are treated in the public sector which is also free but requires time to travel, wait and stay with child if hospitalized or follow instructions to care for the sick child at home.[11] I show that the campaign had larger spillover impacts in cotton-growing regions of Turkey which tend to utilize female labor and do not find significant impacts of the campaign on proxies for household wealth.[12] The notion that time is a key determinant of child health in developing countries has been shown in other studies and was emphasized by UNICEF in the 1985 State of the World's Children Report (**??**).

The structure of the rest of the paper is as follows: section 2 describes the campaign and gendered patterns of time use, section 3 introduces the identification strategy, section 4 describes the data including the construction of vaccine preventable disease prevalence by birth province, section 5 presents the overall and spillover effects of the immunization campaign, section 6 provides a framework for interpreting the results and section 7 concludes with a discussion of the policy implications.

2 Background

2.1 Turkish National Immunization Campaign

In 1980, Jim P. Grant became UNICEF director and shortly thereafter unveiled an initiative known as the child survival revolution which was based on four simple strategies: Growth Monitoring, Oral Rehydration, Breastfeeding and Immunizations (GOBI).[13] As part of the revolution, Grant was searching for a low-resource country that would serve as a showcase for a successful mass immunization campaign. Grant sought out Turgut Özal, a colleague from his days at USAID, and a man who had subsequently gone on to become Turkey's prime minister. Özal agreed with the concept and the planning began. As described in a subsequent UNICEF report, the campaign "had a clear aim: to show that a large middle-income country with high infant mortality and

[10] For the main analytical sample used in the data set, described below, only 13 percent of working women earn wages or a salary. Thus, if the household suffers a major hit to its income due to illness or another event and children are needed to work in the fields, it seems reasonable to suppose this could affect boy chidren more than girl children.

[11] In 1961, Turkey passed a law to socialize it's health service "Statute of Socialization of Health Services". Socialization was defined as providing free services at the point of delivery (with the exception of the cost of drugs), and collecting premiums to pay for the services. The collection of premiums was never implemented, but health centers linked to hospitals for provision of primary care were established and staffed by doctors (recent medical graduates) who were assigned two years compulsory service after graduation (**??**).

[12] I test whether the intervention increased the occupational status of father using the spillover specification and find no evidence of a signicant positive effect (0.017 standard error 0.170). Conditional on father's occupation, there are no significant effects on mother's occupational status.

[13] This section draws heavily on the following publications:
"Rapid Assessment: Turkish National Immunization Campaign of 1985" (**?**)., "Report of the Baseline Survey for the 1985 Turkish National Immunization Campaign" (**?**) and "The Vaccination Situation of Children Between 0-5 Years of Age After the Accelerated Vaccination Campaign and a Comparison with Pre-Campaign Results" (**?**). Unfortunately, only the published results from the baseline survey are available and they are compared to the reconstructed variable in Appendix Figure B3.

barely average EPI coverage could inexpensively vaccinate at least 80 percent of its children–despite barriers of weather, terrain, and population dispersion" (?, page 7).

The campaign began with then Turkish President Kenan Evren vaccinating a baby in front of the press. This launched the first ten day campaign, with two more occurring before the end of the year. The campaign involved an impressive collaboration across sectors. Widespread media messages were conveyed by the press. Imams were given a prepared sermon to deliver from each of the country's 54,000 mosques on the Friday evening before campaign launch which quoted text on the importance of caring for children from the Quran.[14] "Not to miss one single child," became a national motto. Turkish Radio and Television donated free air time and an average of six articles were carried in the main national newspapers every day until the campaign's end. Healthcare workers (physicians and paramedicals) were trained and the cold chain infrastructure was bolstered with private and public donations. The target population precampaign was estimated at 5.1 million children between 0 and 60 months. There were over 45,000 vaccination stations aimed at being within a 10-15 minute travel time from each home. Health centers, mosques and schools as well as a few businesses served as vaccination sites.

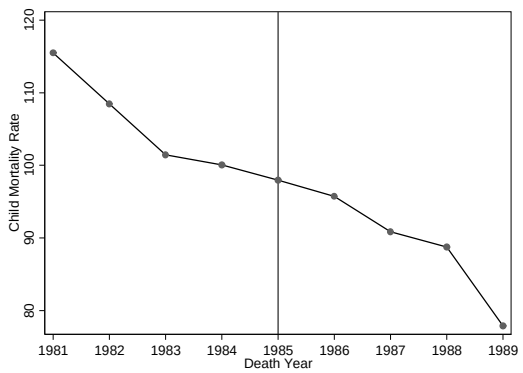
TABLE 1: COVERAGE OF ELIGIBLE POPULATION

Vaccine	*Age Grp*	*Pre (%)*	*Post (%)*
DPT	2-11 months	28	92
&	12-59 months	52	94
OPV	total	47	94
	2-11months	12	72
Measles	12-59 months	40	84
	total	37	83

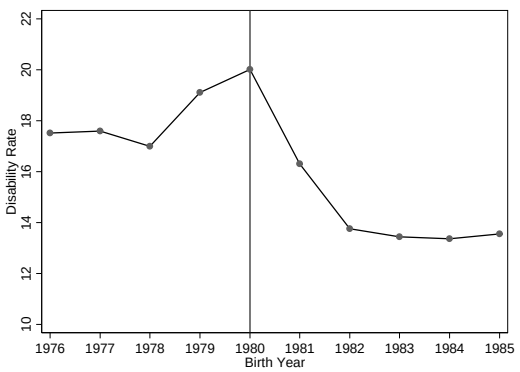
Figure 2 previews the campaign's success and plots health outcome measures over time. Panel A demonstrates a strong downward trend in child mortality that antedates the campaign and is in contrast to Figure B2 Panel A which shows a discontinuous drop in vaccine preventable deaths in 1985. The decline in disability in Figure 2 Panel B also occurs contemporaneous with the campaign.

FIGURE 2: HEALTH EFFECTS OF THE CAMPAIGN

A. Child Mortality



B. Morbidity



Notes: Data presented are from the Demographic and Health Survey (1993, 1998) and the Turkish Census (2000). Data from Panel A are plotted by Death Year, and Panel B are plotted by Birth Year.

[14] See Appendix Figure B1 for photos of the campaign.

2.2 Gender Patterns in Turkey

2.2.1 Time Use

This section seeks to place in context the cultural context in which the immunization campaign was introduced to explore why girls might have benefitted more in response to early child health interventions than boys. The first nationally representative time use survey in Turkey was performed in 2006. Although 20 years after the intervention, the pattern produced below is relevant and was likely more pronounced at the time of the campaign. Figure 3 shows the time (in minutes) that are spent on household activities by age group and gender. The divergence in tasks begins early; with young women 15-24 spending much more time on household activities than their male peers. This results obtain when looking within households. A regression of time (in minutes) spent on household chores on gender and household fixed effects yields limited to never married individuals 15-24 years of age yields a coefficient of 169.19 significant at the 1% level. Within the same household, in 2006, girls spent almost three hours more on household activities than boys do on a typical day.[15]

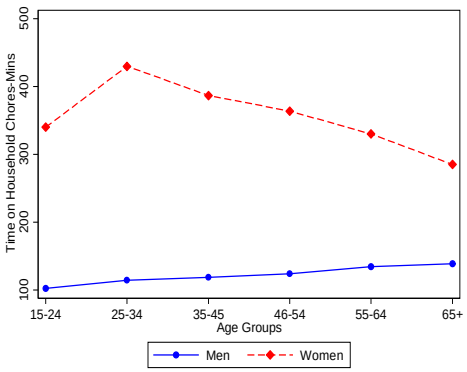
2.2.2 Beliefs about Education

Also relevant to the current analysis are views parents espouse as to which gender is deserving of education. The Demographic and Health Survey from 2008 directly asked women whether they agreed with this statement: "It is better to educate sons than daughters." I limit the sample to mothers born before 1968, so as to recreate the views of the population that would have had young kids at the time of the campaign. Caution should be used when interpreting the results given concerns about survival bias, demand bias and opinions shifting over time. There is heterogeneity in the proportion of mothers that admit to agreeing with this statement, close to zero in some provinces, and almost two-fifths in others. Figure 3 Panel B shows a robust positive correlation between where this view is more openly expressed and the precampaign prevalence of vaccine preventable disease. These graphs provide support for the notion that girls were often tasked with childcare roles (or household chores when a mother is preoccupied with a sick child) and that girls' education was viewed as less important than boys', particularly in areas where the campaign should have had the greatest impact, as described below.

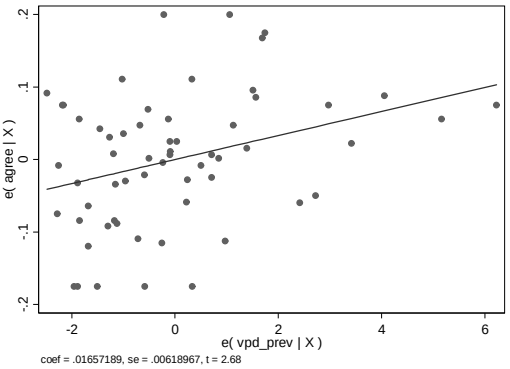
[15] Other studies that have noted the impact of siblings on sisters in particular include **?** and **?**.

FIGURE 3: GENDER ROLES

A. Time Use by Age and Gender



B. Parental Beliefs about Education



Notes: Data plotted are from the 2006 Time Use Survey (Panel A) and the 2008 DHS (Panel B). Panel B displays the partial regression plot of an indicator variable for "agree with the statement, it is better to educate sons than daughters" on VPD prevalence.

3 Empirical Strategy

To identify the effect of the campaign on health and human capital, I employ a difference-in-difference estimator, using the approach pioneered by **?** and adopted by **??** and **?**. I use available health statistics to develop a baseline measure of the prevalence of vaccine prevalence illness at the local geographic level. The national immunization campaign then provides a treatment effect that varies depending on how high the burden of disease is prior to its introduction. Cohorts between 0 to 60 months at the time of the campaign (whose year of birth is between 1980 and 1986) are affected while cohorts born before that time are not directly affected as in a traditional DD framework. The grouped version of this estimator is as follows:

$$Outcome_{pt} = \alpha + \beta \left(VPD_p I_t^{post}\right) + \gamma I_t^{post} + \rho VPD_p + \mathbf{X}'_{pt}\Gamma + \varepsilon_{pt}, \tag{1}$$

where p denotes province and t denotes time. Equation (1) is used because demographic variables such as child mortality are only calculable at the provincial level. $\mathbf{X}_{pt}$ includes average maternal literacy, family size, log number of health personnel, professional status of father, fraction male and urban status in 1985. I next turn to an estimating equation which analyzes outcomes at the individual level, i. This specification allows for the inclusion of individual level controls to increase precision as well as time-varying variables measured at the province level that may be a source of omitted variable bias (**?**, p. 237):

$$Outcome_{ipt} = \alpha + \beta(VPD_p I_t^{post}) + \sum_c \gamma_c I_p^c + \sum_j \rho_j I_t^j + \mathbf{X}'_{ipt}\Gamma + \varepsilon_{ipt}, \tag{2}$$

where I_p^c and I_t^j represent indicator variables for birth province and birth cohorts, respectively. β is the difference-in-difference estimate. $\mathbf{X}_{ipt}$ is a column vector of covariates that vary at the individual, household or birth province level and have been shown to influence children's health and human capital, such as maternal literacy, family size, father's occupation, relationship to

household head and gender.[16] I assess for a gendered impact of the vaccination campaign on health and human capital outcomes by interacting each covariate in the individual-level specification with an indicator for girl. In this specification, β_1 represents the difference-in-difference estimate for boys and β_2 is the differential impact of the campaign for girls versus boys. $\beta_1 + \beta_2$ is the difference-in-difference estimate for girls:[17]

$$\begin{aligned} Outcome_{ipt} &= \alpha + \beta_1(VPD_p I_t^{post}) + \beta_2(VPD_p I_t^{post} I_i^{girl}) + \sum_c \gamma_c I_p^c + \sum_j \rho_j I_t^j + \mathbf{X}'_{ipt}\Gamma \\ &+ \left(I_i^{girl}\mathbf{X}'_{ipt}\right)\Psi + \sum_c \gamma_c^{girl}\left(I_i^{girl} I_p^c\right) + \sum_j \omega_j^{girl}\left(I_i^{girl} I_t^j\right) + \varepsilon_{ipt}. \end{aligned} \tag{3}$$

The inclusion of province of birth fixed effects absorb differences between provinces that might jointly determine a high baseline VPD prevalence and the accumulation of human capital. The individual level regressions include cohort fixed effects to control for any other national policies or events that would affect human capital outcomes in a specific year for children of a given age. The use of province of birth to assign treatment reduces concern about endogenous migration.

To assess for spillover effects of early child health on other household members, I examine the cohort immediately older than the age-eligible population. The sample includes children of household heads who were 11-15 years of age at the time of the 1985 and 1990 census and had younger siblings in the household. This age range is ideal since this group is young enough to still be residing with younger siblings who were targets of the campaign (enabling me to identify those indirectly affected) yet old enough to be ineligible for the campaign themselves. In addition, by 11 years of age, primary school should have been completed at this time in Turkey.

Equation 2 is modified by replacing I_t^{post} with $I_t^{postspillover}$ with the latter equal to one in census year 1990. The estimation strategy compares health and human capital outcomes among individuals born in high versus low prevalence VPD provinces before and after the initiation of the immunization campaign. In order for the underlying variation in vaccine preventable illnesses to be useful as a natural experiment, it must be the case that the program had more of an impact in places where the prevalence of disease was higher. Figure 4 provides support for this approach.[18]

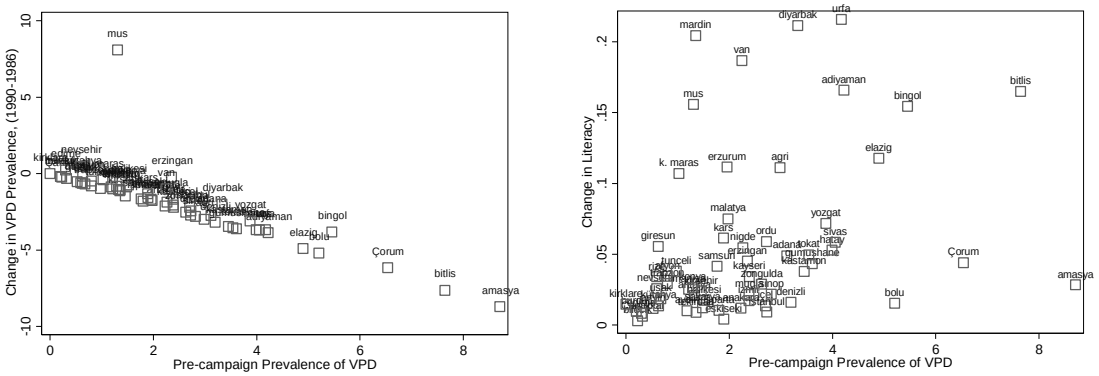
[16] Adding occupation of father and mother's literacy reduces my sample since some older children move out of the household. Including these parental characteristics allows a more direct comparision with the coefficients for the spillover effects in Table 7. Specifications that do not include parental characteristics can be found in Appendix Table B2.

[17] Fully interacted models produce the same coefficients as separate regressions but are more efficient. FGLS regression that does not constrain the residuals to be similar between the two groups produce similar results (**?**)

[18] Reports performed immediately after the campaign reinforce that idea: "The increases in vaccine percentages that the campaign has made possible, have been higher in rural areas and in regions where the percentages were lower before" **?**, page 36. This is reflected in the near total interruption of the targeted diseases in the years immediately following the campaign (Figure 4 Panel A).

FIGURE 4: FIRST STAGE AND REDUCED FORM

A. "First Stage" B. "Reduced Form"



Notes: Panel A data are taken from Ölüm Istatistikleri and plots the difference in VPD prevalence by province between the years 1990 and 1986 on the y-axis and the precampaign VPD prevalence in 1985 on the x-axis. Data from Panel B are from Turkish Censuses and plot the change in the proportion of the sample that is literate on the y-axis and the pre-campaign VPD prevalence on the x-axis. The Census samples include individuals 15-19 years of age and post-campaign is defined as those born between 1980 and 1986.

4 Data Construction

To create a measure of prevalence of vaccine preventable diseases prior to the rollout of the campaign, I use the Turkish Mortality Statistics from 1977 to 1985 (Ölüm Istatistikleri). These data are collected annually and include number, cause and age of death at the province level as well as number of deaths at the district level. Using multiple years smooths out the epidemic nature of vaccine illnesses and corrects for the low frequency of fatal events: $\overline{VPD_deaths}_p = \frac{1}{9}\sum_{1977}^{1985} VPD.deaths$

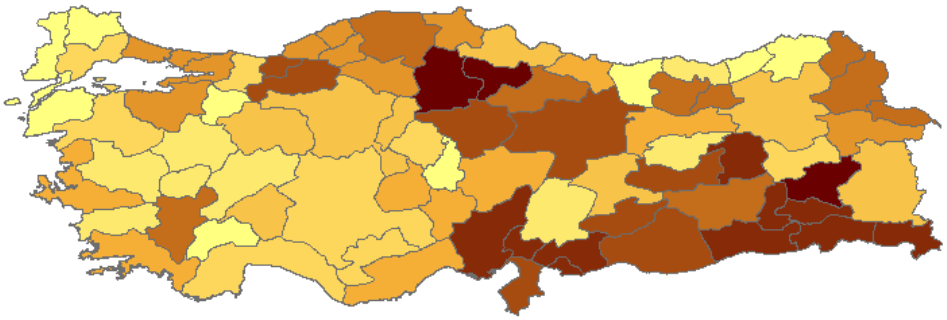
One feature of statistics from low and middle-income countries is the underreporting of vital events to local authorities, particularly in rural areas. Although vital events may be underreported, population counts, enumerated by the federal census, are generally not as badly mismeasured. Since incidence and prevalence rates are normalized by population–the underreporting of vital events is worsened by the use of a federal source for the denominator and a local source for the numerator when attempting to construct a meaningful epidemiologic or demographic measure.[19] To address the problem of nonrandom underreporting of vital events in the administrative data, I exploit a unique question in the 1985 Turkish census to construct a correction factor (CF). The 1985 enumerators asked women whether they had given birth in the last 12 months and whether that baby had survived. Assuming that are no systematic differences between underreporting of infant deaths and deaths from vaccine preventable disease, this ratio can then be used to correct for underreporting in rural areas: $\frac{Infant_Deaths^{census}_{p,1985}}{Infant_Deaths^{istatiskleri}_{p,1985}} = CF_{p,1985}$.

The next step in constructing the prevalence of vaccine preventable disease from deaths is to use information on the case fatality rate (CFR). The CFR is the number of deaths divided by the number of cases of the disease, and can be used to scale up fatalities to represent infections at a particular point in time. One complicating feature is that the CFR may not be constant

[19] Poorly recorded vital statistics are also problematic if using disease or death counts on the left-hand side, even with fixed effects for province, since reporting errors can change over time in ways that are correlated with health interventions or policies.

across space or demographic groups. For example, the CFR may be higher among those with compromised immune systems or with lack of access to healthcare. *A priori*, it's unclear whether the CFR would be higher or lower in more rural settings since the lack of vaccination and access to vitamin A supplementation might be offset by the avoidance of sanitation and safe water supply issues that are associated with density.[20] The simplest approach is to assume a constant CFR across all geographic entities: $\overline{VPD_cases}_p = \frac{\overline{VPD_deaths}_p * CF_p}{CFR}$(**?**).[21] Prevalence at the province level is the number of cases divided by the at risk population (under5 children). A map of VPD prevalence across Turkey prior to the campaign is shown in Figure 5 below.[22]

FIGURE 5: MAP OF PRECAMPAIGN VPD PREVALENCE



Notes: Map of VPD Prevalence in the precampaign period. See text for details of VPD construction.

Micro-level data on human capital outcomes and other household level controls come from the 5 percent Turkish census sample provided by Integrated Public Use Micro Sample (IPUMS) and from the Turkish Statistical Institute (**?**). Census data are available for the years 1985, 1990 and 2000 and include data on literacy, educational attainment and disability. I merge individual observations from the censuses to the precampaign VPD prevalence. Provincial infant and child mortality rates are constructed from individual birth histories collected by the Demographic Health Surveys (DHS) (**?**). Time-varying provincial level data on healthcare access including number health professionals are from the Turkish Statistical Abstract (Türkiye Istatistik Yilligi) and are included in robustness checks (**?**).

The age-eligible sample in the main analysis includes individuals between 15 and 19 years old across two waves of census data, 1985 and 2000. Any individual younger than 15 in 2000 would have been subject to a major education reform in Turkey and must be excluded.[23] Furthermore,

[20] It is most likely, however, that the CFR was higher in areas with the most to gain from the program. This would imply that the precampaign VPD is too low in such areas and understates the benefit of the campaign.

[21] There are also likely different case fatality rates across vaccine preventable diseases, however, finding agreement on the number can be difficult. Since there is much more research on the CFR for measles, and since most of the deaths are attributable to measles, I used the measles CFR estimate.

[22] For five provinces that were historically linked but are now separated and have vastly heterogenous disease risk, I averaged over district cases (derived from the fraction of all provincial deaths in a district) to construct the prevalence measure. Findings are robust (though weaker) if this this heterogenity is ignored.

[23] According to **?** (2011, page 11): "The new compulsory schooling system affected children who started school at

vaccination continued (though at a diminished level) post-campaign potentially affecting younger cohorts. Disability is not available in the 1990 census. I restrict the analysis to children who are still living in their birth province to reduce measurement error associated with treatment assignment. This reduces the sample by about 20%–although results are qualitatively similar without this restriction. Summary statistics are provided in Appendix Table B1.

5 Results

5.1 Effects of the Campaign

The results of equation (1) are presented in Table 2. Consistent with Figure 2, there are no appreciable effects on the vaccination campaign on child or infant mortality. However, I find statistically significant gains for both morbidity (measured as disabled) and human capital accumulation at this level of aggregation.[24] The coefficient on VPD prevalence is insignificant (except for the outcome of disability) which lends some support for the identifying assumption that, in the absence of the campaign, groups with high and low vaccine preventable illness would have experienced similar changes in the outcome variables. Based on the low overall fatality rate from vaccine preventable disease at this time, these results, in retrospect, may not appear particularly surprising.

Table 2: Effects of The Campaign: Province-Level

Dependent Variable	Disabled	Literate	Less than Primary	Log Child Mortality Rate	Log Infant Mortality Rate
	(1)	(2)	(3)	(4)	(5)
VPD Prevalence	-0.0006**	0.0129**	-0.0130**	0.0045	-0.0493
*Post	(0.0003)	(0.0059)	(0.0059)	(0.0289)	(0.0390)
Post	0.0074***	-0.0176	0.0464***	-0.2100	-0.1528
	(0.0012)	(0.0165)	(0.0168)	(0.1318)	(0.1634)
VPD Prevalence	0.0005**	-0.0050	0.0047	0.0276	0.1106***
	(0.0002)	(0.0046)	(0.0053)	(0.0386)	(0.0329)
Observations	122	122	122	120	114
R-squared	0.3776	0.7441	0.7845	0.2632	0.2652
Number Clusters	61	61	61	60	57

Notes: OLS estimates of Equation (1). Child mortality constructed using birth history data from DHS 1993 and 1998. Literacy, Disability, Primary and Cohort counts come from the Turkish Census. In addition to the variables shown (VPD prevalence, post and the interaction), the regression also controlled for urban status, average mother's literacy, family size, father's professional status, fraction male and log of hospital personnel. Standard errors clustered at the province level. * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

5.2 Threats to Identification

In order for the difference in difference estimate to be interpreted as a causal effect, it must be that VPD prevalence in the precampaign period is as good as randomly assigned conditional on

or after September 1993, we assume that children who were born in 1986 or later were bound by the policy." Note that the youngest child in my sample is born in 1985.

[24] Although cohort size has been used as a surrogate for vital statistics in developing countries, it conflates all causes of population growth (fertility, migration and mortality reductions) and therefore the results should be interpreted with caution.

covariates and places of varying precampaign VPD prevalence must be on parallel trends. Table 3 addresses the first claim. Column (1) presents summary statistics for the age-eligible province level sample used in Table 2. In column (2) I regress each covariate on VPD prevalence alone and in column (3) I include all other covariates in the analysis. Although precampaign VPD prevalence is positively associated with less human capital and larger families, once conditioning on covariates, VPD prevalence fails to predict most of the variables in the precampaign period, except for disability (the implicit first stage).

TABLE 3: SUMMARY STATISTICS

Province Characteristics in 1985 by VPD Prevalence			
Variable	All	VPD Prevalence	
		without controls	*with controls*
Disabled	0.012	0.0006***	0.0005**
	[0.003]	(0.0002)	(0.0002)
Literate	0.904	-0.0237**	0.0001
	[0.116]	(0.0091)	(0.0033)
Less than Primary School	0.135	0.0281**	-0.0004
	[0.135]	(0.0108)	(0.0039)
Father Professional	0.158	-0.0023	-0.00005
	[0.044]	(0.0023)	(0.0026)
Mom Literate	0.445	-0.0414***	-0.0054
	[0.187]	(0.0128)	(0.0067)
Family Size	6.263	0.2668***	0.0521
	[1.179]	(0.0833)	(0.0507)
Urban (1985)	0.443	0.0199	0.0235
	[0.501]	(0.0339)	(0.0402)
Male	0.517	-0.0015	-0.0011
	[0.025]	(0.0017)	(0.0021)
Log Health Personnel	5.787	0.0114	0.0380
	[0.857]	(0.0509)	(0.0650)
Number Provinces	61	61	61

Notes: Column 1 reports average values for the 61 provinces with standard deviation in brackets. Columns 2 and 3 report coefficients from a single regression of indicated county characteristics in the pre-vaccination period on VPD prevalence. Column 3 adds controls described in Table 2. Robust standard errors are reported in parentheses. * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

To address the concern about differential trends between places with more versus less disease at baseline, I perform a falsification test where I estimate equation (1) substituting the period 1970-1975 as the period of analysis. (Note that I cannot use 1975 to 1980 as a placebo post period for human capital outcomes due to spillover effects for elder household members demonstrated below). The results are shown in Table 4–the interaction of placebo post and VPD prevalence is no longer a significant predictor of morbidity or human capital.

Table 4: Falsification Test

Dependent Variable	Disabled	Literate	Less than Primary
	(1)	(2)	(3)
VPD Prevalence*Placebo	-0.0001	-0.0033	0.0066
Post	(0.0004)	(0.0036)	(0.0048)
Post	0.0001	-0.0044	-0.3628***
	(0.0011)	(0.0105)	(0.0133)
VPD Prevalence	0.0004	0.0020	-0.0031
	(0.0003)	(0.0044)	(0.0036)
Observations	122	122	122
R-squared	0.1364	0.7335	0.9425
Number Clusters	61	61	61

Notes: OLS estimates of Equation (1) estimated on individuals born between 1970 and 1975. Placebo post =1 if year of birth>=1973. Literacy, Disability and Less than Primary are from the Turkish Census. In addition to the variables shown (VPD prevalence, post and the interaction), the regression also controlled for urban status, fraction male, average mother's literacy, family size and professional status of father. Standard errors clustered at the province level. * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

I next turn to estimating the impact of the campaign using micro-level data from individuals. These specifications allows for the inclusion of time-varying provincial level variables which may be a source of omitted variable bias such as mother's literacy, father's occupational status, family size, gender and relationship to household head (**??**).[25] Table 5 reports results for three outcomes: disabled, literate and less than primary school completion.[26] Columns (1) (3) and (5) estimate equation (2). A one standard deviation increase of vaccine preventable illness in the precampaign period was associated with approximately a .6 percentage point decline in disability and a 2 percentage point increase in literacy and primary school completion. The low overall mean of disability in the population (about 1 percent) likely reflects under-reporting. If this under-reporting is worse in areas that were heavily impacted by the campaign, areas with high VPD prevalence at baseline, this would weaken my ability to detect an effect of the campaign.[27] Results without parental characteristics are shown in Appendix Table B2.

Columns (2) (4) and (6) estimate equation (3) and formally test whether the marginal effect of the campaign differed for boys versus girls. For disability, the impact of the campaign for girls is indistinguishable of that for boys. Yet the total estimated impact of the campaign on literacy is significantly larger for girl children (0.019 compared to 0.008). How could boys have similar health gains but smaller human capital gains from the campaign? One possibility is due to parental

[25] Time-varying health care infrastructure is included as an additional control in Table 6.

[26] Because recoding prevents me from looking at school attainment for children born in 1984 and 1985, I use the DHS individual recode file for women. These data have education, height as well as total number of children recorded. Although province of birth is not provided across all waves, childhood province is recorded. I include women 19-23 in the 1993, 1998 and 2003 DHS, which is consistent with the 15-19 year old sample constructed using the census (though they are compared to the cohort immediately below them). The 1993 and 2003 are an "ever married" sample so I control for marital status in all regressions. Similar to the main results, I estimate the equation on those who remain in province of childhood to reduce measurement error in the treatment variable. Results are shown in Table B4 and are consistent with those presented in Table 5 demonstrating gains to human capital, but not to height, from the vaccination campaign.

[27] There is evidence that underreporting of disability may be an issue in high prevalence of VPD areas since the level of disability is approximately equal in provinces above and below the mean prevalence, yet the burden of disease is much higher in high prevalence areas.

discrimination: for the same level of disability, less effort is made by parents to educate girls versus boys (e.g. a different disability "threshold" exists for girls and boys).[28] Indeed, appendix table B5 demonstrates the effect of disability on literacy is more negative for girls than boys, though the magnitude of the difference (0.037) is fairly small. A second (and not mutually exclusive) possibility is that girls are benefitting from the campaign through an additional channel that is not related to improved own health. In other words, the estimates below might reflect both direct and spillover effects for girls, but mostly direct health benefits for boys. Recall that vaccination continued for children born after 1985, and therefore these individuals likely benefitted from having healthier younger children in their household–a hypothesis I examine in detail below.[29] Tentative support for such a possibility is provided by the gender-family size interactions: larger families have a much more negative impact on girls human capital than boys.

A series of robustness checks are performed in Table 6 and in the appendix. First, region-year fixed effects are included to control nonparametrically for any shocks to a region (Table 6, columns 1 and 2). Although literacy is no longer statistically significant; the point estimate is comparable to baseline. Second, I add birth province interacted with a linear trend for year of birth (although there is a discontinuous jump between samples) although literacy retains significance and the expected sign, disability flips signs and is significant at the 10% level. Columns (5) and (6) include time-varying health professionals and the last two columns adjust for mean reversion. In Appendix Table B3 I assess robustness to restricting to only urban or rural areas (as defined in 1985) and to dropping Kurdish areas. Results are similar across these specifications.[30]

5.3 Spillovers to Older Siblings

I next turn to elucidating whether the intervention had an impact on older siblings of children age-eligible for the intervention by using specification 2 and replacing I_t^{post} with $I_t^{postspillover}$ as described above. The results are reported in Table 7. I cannot test for spillover effects on disability since it was not reported in the 1990 census.

[28] See **?** for a model of different threshold effects applied to racial discrimination.

[29] Living in a household with vaccinated family members would also benefit young children's health.

[30] Results are robust to adding province of birth interacted with an indicator for census year or an indicator for year of birth, but when using a continuous version of year of birth (though the sample is discontinuous in year of birth–1966-1970 and 1981-1985) the results for disability flip sign and are significant, though literacy is correctly signed and significant.

TABLE 5: EFFECTS OF THE CAMPAIGN: INDIVIDUAL LEVEL

Dependent Variable	Disability		Literacy		Less than Primary School	
	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Gender Interacted	Baseline	Gender Interacted	Baseline	Gender Interacted
VPD Prevalence*Post	-0.0004*	-0.0003	0.0140**	0.0102**	-0.0138**	-0.0093*
	(0.0002)	(0.0003)	(0.0058)	(0.0049)	(0.0058)	(0.0049)
VPD Prevalence *Post *Girl		-0.0003		0.0088**		-0.0105**
		(0.0004)		(0.0038)		(0.0040)
Total Marginal Effect for Girls		*-0.000563***		*0.0190***		*-0.0198***
		(0.000280)		*(0.00769)*		*(0.00793)*
Observations	342,197	342,197	342,096	342,096	296,390	296,390
R-squared	0.0024	0.0027	0.1591	0.1959	0.1430	0.1698
Year of Birth Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Birth Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Parental Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
No. Clusters	61	61	61	61	61	61

Notes: OLS estimates of equation (2) reported in columns (1) (3) and (5). Province of birth and year of birth fixed effects included in every regression. Columns (2) (4) and (6) reports results from specification (3), in which each explanatory variable is interacted with an indicator for girl. Demographic characteristics in every specification include gender and relationship to household head. Parental characteristics refer to occupational status of the father, family size and an indicator for maternal literacy. Standard errors clustered at the province level. * ** *** represents significance at the 10, 5, and 1 percent level, respectively.

TABLE 6: ROBUSTNESS CHECKS

	Region-Year FE		*Province*Linear YOB*		*Health Professionals*		*Mean Reversion*	
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Disabled	Literate	Disabled	Literate	Disabled	Literate	Disabled	Literate
VPD Prevalence*Post	-0.0005**	0.0012	0.0022*	0.0146*	-0.0004*	0.0132**	-0.0004	0.0051**
	(0.0002)	(0.0025)	(0.0012)	(0.0074)	(0.0002)	(0.0053)	(0.0003)	(0.0023)
Observations	342,197	342,096	342,197	342,096	342,197	342,096	342,197	342,096
R-squared	0.0025	0.1703	0.0026	0.1706	0.0024	0.1594	0.0024	0.1677
Year of Birth Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Clusters	61	61	61	61	61	61	61	61

Notes: OLS estimates of equation (2). Province of birth and year of birth fixed effects included in every regression. Demographic characteristics in every specification include gender and relationship to household head. Parental characteristics refer to occupational status of the father, family size and an indicator for maternal literacy. The first two columns includes region –year of census fixed effects. Column (3) and (4) include province year of birth linear trends. Columns (5) and (6) add health professionals and (7) and (8) assess for robustness to mean reversion. Standard errors clustered at the province level. * ** *** represents significance at the 10, 5, and 1 percent level, respectively.

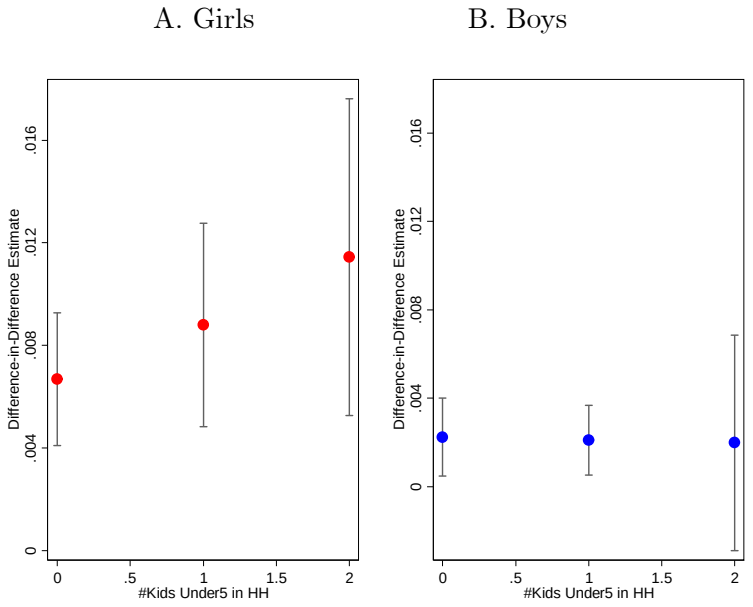
TABLE 7: SPILLOVER EFFECTS OF THE CAMPAIGN

Dependent Variable	Literate					Less than Primary School				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Baseline	Gender Interacted	Mother Works Outside Home	Cotton Producing Area	Young Children in HH	Baseline	Gender Interacted	Mother Works Outside Home	Cotton Producing Area	Young Children in HH
VPD Prevalence*PostSpillover	0.0052**	0.0020	0.0024	0.0014	0.0014	-0.0053**	-0.0005	0.0002	-0.0032	-0.0022
	(0.0022)	(0.0014)	(0.0017)	(0.0021)	(0.0016)	(0.0024)	(0.0021)	(0.0021)	(0.0034)	(0.0022)
VPD Prevalence *PostSpillover*Girl		0.0068***	0.0079***	0.0094**	0.0080***		-0.0105***	-0.0110***	-0.0136***	-0.0096**
		(0.0021)	(0.0024)	(0.0034)	(0.0028)		(0.0027)	(0.0030)	(0.0037)	(0.0037)
Total Marginal Effect for Girls		*0.00886***	*0.0104***	*0.0108***	*0.00939***		*-0.0109***	*-0.0108***	*-0.0169***	*-0.0118***
		(0.00326)	*(0.00316)*	*(0.00512)*	*(0.00368)*		*(0.00350)*	*(0.00292)*	*(0.00587)*	*(0.00406)*
Observations	254,831	254,831	128,443	130,250	124,197	254,495	254,495	128,287	130,092	124,006
R-squared	0.1762	0.2123	0.2498	0.2290	0.2247	0.2121	0.2260	0.2432	0.2327	0.2252
Year of Birth Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Clusters	61	61	61	23	61	61	61	61	23	61

Notes: OLS estimates of equation (2) reported in columns (1) and (6) and specification (3) reported in the remaining columns where post spillover is substituted for post. The sample consists of children of household heads who have a sibling under 10 in the household. Province of birth and year of birth fixed effects included in every regression. Demographic characteristics in every specification include gender. Parental characteristics refer to occupational status of the father, family size and an indicator for maternal literacy. Columns (3) and (8) estimate specification (3) on a subsample of children whose mother states she works outside the home (not necessarily for pay). Columns (4) and (9) include children who live in cotton producing areas. Columns (5) and (10) include children whose mothers have at least two kids under 5 in the household. Standard errors clustered at the province level. * ** *** represents significance at the 10, 5, and 1 percent level, respectively.

In column (1), the spillover difference-in-difference estimate is positive and significant at the 1% percent level (.0068) and approximately $\frac{1}{2}$ the magnitude reported in Table 5 column (3). However, when moving to specification (3) in columns (2), these results are driven by β_2 , the differential spillover effect for girls as β_1 is insignificant. These results imply the spillover impacts of young children's health to the human capital of older siblings in the household accrued mainly to girls. Limiting the analysis to a subsample of children whose mothers state they work outside the home widens this gender difference (columns (3) and (8)) as does limiting to cotton-growing areas (cotton fields were mainly attended by women in Turkey).[31] These results lend support to the notion that when time was particularly scarce, due to mothers needing to work outside the home, the benefits of improved children's health to older girl siblings are stronger. Focusing on a sample of older siblings with more than one child under the age of 5 at home (columns (5) and (10)) also widens the gendered spillover response for the literacy outcome.

FIGURE 6: GENDERED SPILLOVER RESPONSE TO CAMPAIGN



Notes: OLS estimates of equation (3) separately by gender and number of children under5 in the household. Figure represents the marginal spillover effect of the campaign for girls (Panel A) versus boys (Panel B). Plotted are the coefficients (points) and standard error bars.

Figure 6 plots the marginal differential spillover effect of the campaign on girls versus boys by the number of children under 5 years of age in the household for the literacy outcome. Although there is less mass at 3+, and therefore wider standard errors, the results show a pattern consistent with Figure 1–namely, the benefits of mass dissemination of the vaccine technology were higher for girls than boys and this difference increased in the number of young children in the household.

[31] An estimated 80% of workers in cotton fields in Turkey's Mediterean region are women (Rashid Ergener, Reşit Ergener 2002, p. 20). Another report estimates that 80%of the workforce that is engaged in cotton harvesting in Turkey are women (Women in Cotton: Results of a Global Survey, 2011 p.7).

6 Model of Intrahousehold Time Allocation in the Presence of Sick Young Kids

In this section, I develop a simple model which seeks to interpret the empirical findings. Building on the work of **?**, parents seek to maximize a parental welfare function that gives equal weight to each child and is additively separable in their own consumption μ and a vector of expected earnings ($\mathbf{E}$) for each of their i children. $U(\mu, E_i) = V[\mu, W(\mathbf{E}_i)]$. Following **?** I ignore the sequential nature of the decisionmaking and view allocation as a one-period problem taking the number of children as a given.

To focus attention on the salient features of the applied work, I assume there are three children per household: an older, schoolage boy sibling indexed with b, an older, schoolage girl sibling indexed with g and an under5 younger child indexed with y. The expected earnings of each i child is a function of their time in school S and an early childhood input of time, X, which is necessary for child survival and development: $E_i = E(S_i, X_i)$.

Thus for older schoolage children, the Xs are fixed and the parents must decide how much time they may spend in school.[32] For under5 pre-school children, parents decide how much time to allocate to their early development and survival. Genetics come into play not in differing scholastic aptitude between the sexes, but rather from the greater efficiency girls have in translating their own time into child development. This is important since the binding budget constraint on the household is not monetary (since schooling is free) but rather time. Thus, units of time devoted to care for younger siblings Z, to meet the required X, is given by (up to a constant of parental time): $X_y(I) = \alpha Z_b + Z_g$, where the older boy's input of time is discounted by $\alpha \epsilon (0, 1)$ to reflect this gendered relative efficiency. X depends on illness (I) because sick children require more time to assure their survival.[33]

Older children have a time budget (T) that is split between caretaking for younger children (Z) and schooling (S). There is a skilled and unskilled wage that is the same across genders and for older and younger siblings. For any child i the expected earnings is therefore: $E_i = p(S_{i,}X)w_s + (1 - p(S_{i,}X_i))w_u$, where p is the probability of earning the skilled wage. The probability function $p(\cdot)$ is strictly concave and increasing in all arguments. Putting all these elements together, the parents objective function is as follows:

$$\begin{aligned} \max_{S_b S_g} U(\mu, E_i) &= v(\mu) + p(S_b, X)w_s + (1 - p(S_b, X))w_u + p(S_g, X)w_s + (1 - p(S_g, X))w_u + \\ &\quad p(X_y(I))w_s + (1 - p(X_y(I))w_u \\ s.t.\ X_y(I) &= \alpha Z_b + Z_g,\ T = Z_b + S_b \text{ and } T = Z_g + S_g \end{aligned}$$

Proposition 1 *In equilibrium, boys are allocated more time in school than girls.*

Proof. Normalizing the unskilled wage to 0 and maximizing the above yields: $p'(S_b^*) = p'(S_g^*)\alpha$. Since $\alpha \epsilon (0, 1)$, $p'(S_g^*) > p'(S_b^*) \Leftrightarrow S_g^* < S_b^*$.[34] ■

[32] For the younger child, who by assumption will not have to divide time between child-care and school going, the S is the maximum.

[33] See **?** study for an example of the importance of time from a caregiver for child survival in developing countries.

[34] Relaxing the assumption that female skilled wage is as high male skilled wage (so $w_g < w_b$), further increases

Proposition 2 *Girls' schooling increases when younger siblings are healthy and is more responsive to siblings health than boys' schooling.*

Proof. from the $FOC:\ S_g^* = p'^{-1}p'(X(I)) \rightarrow \frac{\partial S_g^*}{\partial I} = p(\cdot)^{-1''}p(\cdot)''\frac{\partial X}{\partial I} < 0$ since the inverse of a concave function is convex, the 1st and 3rd term are positive and the 2nd is negative. Similarly: $\frac{\partial S_b^*}{\partial I} = \alpha p(\cdot)^{-1''}p(\cdot)''\frac{\partial X}{\partial I} < 0$ which is less than the comparative static for girls by α.[35] ■

7 Policy Implications and Concluding Remarks

Prior studies in economics have documented unintended consequences of large scale public health interventions (##cites). The Turkish National Immunization campaign was instituted with broad-based political and religious support and the documented gains in vaccine coverage were impressive. Although I find no evidence that the intended benefits on mortality reduction were realized, the impacts on human capital were substantial

As child survival continues to improve in developing countries, the emphasis should shift from mortality to morbidity. The spillover effects associated with improving the health of young children on the human capital attainment of older girl household members is yet another reason to look beyond mortality to other outcomes (namely, morbidity and gender equity) when assessing the full impact of early childhood health interventions in developing countries.

References

Adhvaryu, A. and A. Nyshadham (2014). Endowments at Birth and Parents' Investments in Children. *The Economic Journal*.

Alesina, A. F. and E. L. Ferrara (2014). A Test of Racial Bias in Capital Sentencing. *American Economic Review 104*(11), 3397–3433.

Almond, D. and J. Currie (2011). Killing Me Softly: The Fetal Origins Hypothesis. *Journal of Economic Perspectives 25*(3), 153–72.

Angrist, J. and J.-S. Pischke (2009). *Mostly Harmless Econometrics: An Empiricist's Companion* (1 edition ed.). Princeton University Press.

Barron, P., E. Buch, G. Behr, and N. Crisp (1987, September). Mass Immunisation Campaign - Do They Solve the Problem? *South African Medical Journal 72*, 321–322.

Behrman, Jere R., P. R. A. and P. Taubman (1982). Parental Preferences and Provision for Progeny. *Journal of Political Economy 90*(1), 52–73.

Bhattacharya, Jay, G. C. and G. Miller (2013). The Gorbachev Anti-Alcohol Campgian and Russia's Mortality Crisis. *American Economic Journal. Applied Economics 5*(2), 232–260.

disparities in human capital accumulation between older girls and boys since $p'(S_b^*) = \frac{w_g}{w_b}\alpha p'(S_g^*)$. Moreover, this reduction is the same regardless of whether the young child is a boy or a girl. However, the tradeoff (first order condition) for the older sibling's human capital vis-a-vis the younger sibling's is more favorable for the older son if the younger sibling is a girl.

[35] To model worsening gender gap with number of children under5 (N), consider extensions such as $X(I(N))$ or α^N .

Black, S. E. and P. J. Devereux (2011). Recent Developments in Intergenerational Mobility. *Handbook of labor economics 4*, 1487–1541.

Bleakley, H. (2007). Disease and Development: Evidence from Hookworm Eradication in the American South. *The Quarterly Journal of Economics 122*(1), 73–117.

Bleakley, H. and F. Lange (2009). Chronic Disease Burden and the Interaction of Education, Fertility, and Growth. *The Review of Economics and Statisstics 91*(1), 52–65.

Bloom, D. E., D. Canning, and E. S. Shenoy (2012). The Effect of Vaccination on Children's Physical and Cognitive Development in the Phillipines. *Applied Economics 44*(21), 2777–2783.

Card, D. (1992). Using Regional Variation in Wages to Measure the Effects of the Federal Minimum Wage. *Industrial and Labor Relations Review 46*(1), 22–37.

Currie, J. and T. Vogl (2013, August). Early-Life Health and Adult Circumstance in Developing Countries. *Annual Review of Economics 5*, 1–36.

Fisek, N. H. and R. Erdal (1985). Primary health care: a continuous effort. In *World Health Forum*, Volume 6, pp. 230–1.

Franzese, R. and C. Kam (2007). *Modeling and Interpreting Interactive Hypotheses in Regression Analysis: A Refresher and Some Practical Advice* (1 edition ed.). University of Michigan Press.

Goldin, C. (1991). *Understanding the Gender Gap: An Economic History of American Women.* Oxford University Press.

Güriş, D., Y. Bayazıt, Ü. Özdemirer, V. Buyurgan, C. Yalnız, İ. Toprak, and S. Aycan (2003). Measles Epidemiology and Elimination Strategies in Turkey. *Journal of Infectious Diseases 187*(Supplement 1), S230–S234.

Kirdar, M., M. D. Tayfur, and İ. Koç (2011). The Effect of Compulsory Schooling Laws on Teenage Marriage and Births in Turkey. *IZA Discussion Paper 5887*.

LeVine, R. and M. Rowe (2009). Maternal Literacy and Child Health in Less-Developed Countries: Evidence, Processes, and Limitations. *Journal of Developmental and Behavioral Pediatrics 30*(4), 340–349.

"Macro International" (1993, 1998, October). Turkish Demographic and Health Survery. Technical report.

Miller, G. and B. P. Urdinola (2010). Cyclicality, Mortality, and The Value of Time: The Case of Coffee Price Fluctuations and Child Survival in Colombia. *Journal of Political Economy 118*(1), 113–155.

Mina, M. J., C. J. E. Metcalf, R. L. de Swart, A. Osterhaus, and B. T. Grenfell (2015). Long-term measles-induced immunomodulation increases overall childhood infectious disease mortality. *Science 348*(6235), 694–699.

Orenstein, W. A., R. T. Perry, and N. A. Halsey (2004). The Clinical Significance of Measles: A Review. *Journal of Infectious Diseases 189*(Supplement 1), S4–S16.

Oster, E. (2009). Does increased access increase equality? Gender and child health investments in India. *Journal of Development Economics 89*(1), 62 – 76.

Ozier, O. W. (2014). Exploiting Externalities to Estimate the Long-Term Effects of Early Childhood Deworming. *World Bank Policy Research Working Paper* (7052).

Pande, R. P. (2003). Selective gender differences in childhood nutrition and immunization in rural India: the role of siblings. *Demography 40*(3), 395–418.

Parman, J. (2013, October). Childhood Health and Sibling Outcomes: The Shared Burden and Benefit of the 1918 Influenza Pandemic. Working Paper 19505, National Bureau of Economic Research.

Ruggles, S., J. T. Alexander, K. Genadek, R. Goeken, M. B. Schroeder, and M. Sobek (2010). Integrated Public Use Microdata Series: Version 5.0. Machine-readable database.

Topalli, R. (2015, April). Primary Health Care in Turkey A Brief History and Current Situation. Kocaeli University Medical School Department of Family Medicine.

Tuncbilek, E., S. Cerit, T. Unalan, B. Akadli, and A. Toros (1985). Report on the Baseline Survery for the 1985 Turkish National Immunization Campaign. *Turkish Journal of Population Studies 7*, 5–26.s.

Tunçbilek, E., M. Ulusoy, A. Hancioglu, T. Unalan, S. Cerit, S. Uner, A. Toros, B. Akadli, I. Kulu, and O. Ayhan (1986). The Vaccination Situation of Children Between 0-5 Years of Age After the Accelerated Vaccination Campaign and a Comparison with Pre-Campaign Results. *Turkish Journal of Population Studies 8*, 5–36.s.

TurkStat (1983, 1989). Türkiye Istatistik Yilligi. Technical report, Turkish Government.

UN (2008). Legislative Reform on Child Domestic Labour: A Gender Analysis. Technical report.

UNICEF (1985). "State of the World's Children". *UNICEF*.

UNICEF (1986). Rapid Assessment: Turkish National Immunization Campaign of 1985. Technical report, UNICEF.

Vogl, T. (2013). Marriage Institutions and Sibling Competitiion Evidence From Souh Asia. *The Quaterly Journal of Economics*, 1017–1072.

8 Appendices

8.1 Appendix A: Data Sources and Variable Definitions

Vaccine Preventable Disease Prevalence: Please see Section 5 for a detailed description of the derivation. Vaccine preventable deaths include diphtheria, pertussis, polio and measles. These data

are taken from Turkish Mortality Statistics (Ölüm Istatistikleri) over the years 1977 to 1985. The average of these values at the province level is multiplied by the correction factor, divided by the case fatality rate and then the number of cases is divided by the under5 population calculated from the 1985 Turkish census.

Cotton: 1985 production data on cotton and cottonseed from the Agricultural Structure and Production Dataset published by the Prime Ministry State Institute of Statistics, Turkey. For each province, total production in tons was entered and divided by the hectares. Provinces with high cotton production were defined as those above the median.

Education Years: Education in years is a variable in the Turkish DHS individual female recode in 1993, 1998 and 2003.

Total Kids: Total children ever born is a variable in the Turkish DHS individual female recode in 1993, 1998 and 2003.

Less Than Primary Completed: Less than Primary is an indicator variable equal to one if the respondent has not completed primary school and is age-eligible to have completed it (e.g. respondents that are "not in the universe" are recoded as missing as are those with the response "don't know"). This variable is taken from the edattan variable in the Turkish census, and is the IPUMS recode for schooling. This question was asked of individuals 12 and above.

Literate: Literate is ascertained through a question on the Turkish Census and is an indicator variable equal to one if the person is literate. According to the original Turkish census forms, the definition of person who is literate : "LIT indicates whether or not the respondent could read and write in the Turkish language. A person is typically considered literate if he or she can both read and write. All other persons are illiterate, including those who can either read or write but cannot do both (?)." This question was asked of individuals 6 and above. Literate is also asked in the Demographic and Health Surveys and is defined as, "reads easily".

Disabled: Disabled is ascertained through a question on the Turkish Census (though is not available in 1990) and is an indicator variable equal to one if the person is physically disabled. The definition of a person having a disability is as follows: "DISABLE indicates whether the person reported a disability of any kind (?)."

Mother Literate: This variable is also ascertained through a question on the Turkish Census and is an indicator variable equal to one if the individual's mother was literate.

Urban: Urban-rural status in an unharmonized variable in the Turkish Census and is an indicator variable equal to one if the dwelling is part of city in Census year 1985..

Health Personnel and Hospitals by Province: Data on the number of practitioners and (public and private) hospitals by province and year are available from Turkish Statistical Abstract (Türkiye Istatistik Yilligi). The natural log of health personnel and hospitals are included in robustness tests.

Birth Province: This variable is obtained through a question on the Turkish Census.

Year : This variable represents the survey year of the census.

Childhood Province: This variable is asked in the DHS 1993, 1998 and 2003 individual female recode.

Age: This variable represents the age of the individual in the year of the survey.

Year of birth: This variable is calculated as year of survey minus age.

Infant Mortality Rate: This variable is calculated at the province level using the Turkish De-

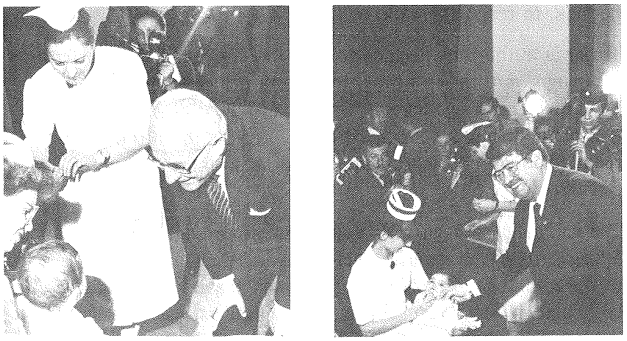
mographic and Health Surveys from 1993 and 1998 and is defined as the total number of deaths of infants (children under the age of one) divided by the total number of births. This ratio is then multiplied by 1000.

Child Mortality Rate: This variable is calculated at the province level using the Turkish Demographic and Health Surveys from 1998 and is defined as the total number of deaths of children between 1 and 5 divided by the total number of children born during that period. This ratio is then multiplied by 1000.

8.2 Appendix B: Additional Tables

Appendix Figure B1: The Strategy of Mass Vaccination

A. Political leaders Lend Support

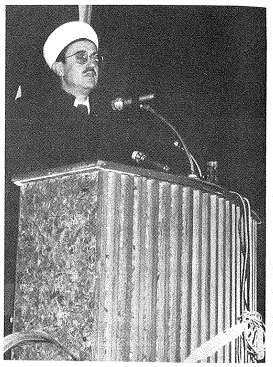


President Evren and Premier Özal lead the campaign.

B. Participation by Clergy

Men of religion were asked to help:

The Directorate of Religious Affairs contacted directly, issued an official circular to the imams in Turkey's Mosques, calling on their support. The directorate also agreed to publish articles and sermons on the benefits of immunization in its monthly gazette. A sermon was prepared for Imams to preach simultaneaously on the eve of the campaign through the loudspeakers of the country's 54,000 Mosques, many of which also served as



Men of Religion gave sermons.

Appendix Figure B2: Cause of Death and Infant mortality

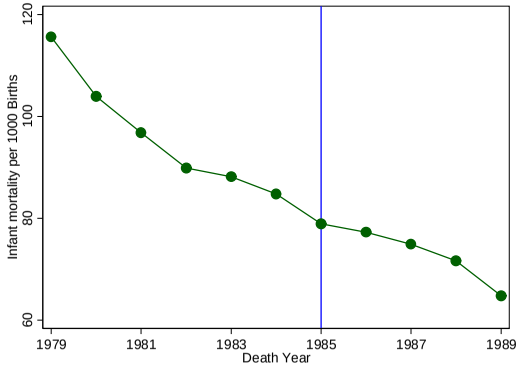
A. Vaccine Preventable Disease Mortality



B. Pneumonia and Enteritis Mortality



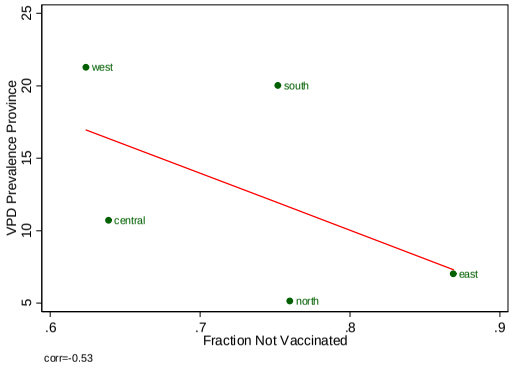
C. Under5 Mortality



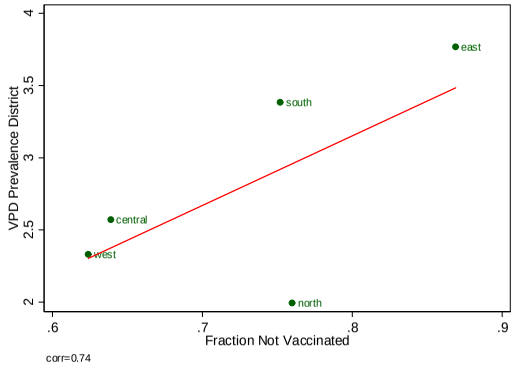
Notes: Figure plots the time series of diseases from the vital statistics (Panel A and B) and under 5 mortality from the DHS (Panel C).

Appendix Figure B3: measures of the Burden from VPD

A. Uncorrected



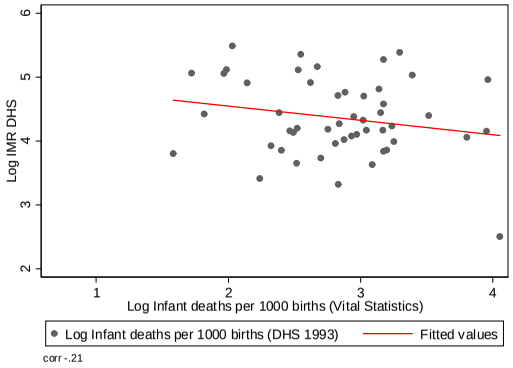
B. Corrected



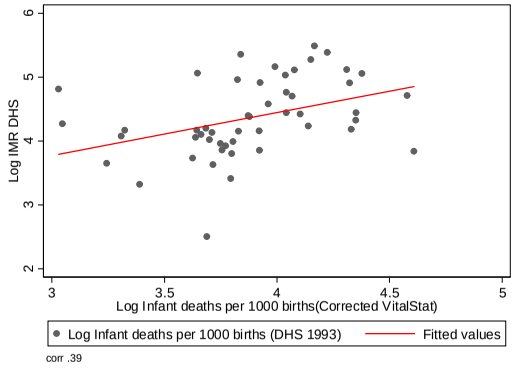
Notes: Figure plots the correlation between VPD prevalence regional percent unvaccinated in 1985. VPD prevalence based on the author's calculation. Data on percent vaccinated are from the published results of a baseline survey (Tuncibelik (1985)). Finer geographic variation from the survey not available.

Appendix Figure B4: measures of Infant Mortality

A. Uncorrected



B. Corrected



Notes: Data presented are from the Demographic and Health Survey (1993 1998) Ölüm Istatistikleri, and the Turkish Census (1985). Data from Panel A demonstrate the correlation between Infant Mortality and Vital Statistics IMR without the correction for under-reporting. Data from Panel B demonstrate the same relationship after applying the correction factor. See text for details on correction factor construction.

Table B1: Summary Statistics

Table B2: Robustness-Drop Parental Characteristics

Dependent Variable	Disabled		Literate		Less Than Primary School	
	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Gender Interacted	Baseline	Gender Interacted	Baseline	Gender Interacted
VPD Prevalence*Post	-0.0003	-0.0003	0.0147**	0.0103**	-0.0135**	-0.0088*
	(0.0002)	(0.0003)	(0.0060)	(0.0050)	(0.0056)	(0.0047)
VPD Prevalence *Post *Girl		-0.0000		0.0090**		-0.0097**
		(0.0003)		(0.0036)		(0.0037)
Observations	476,178	476,178	475,975	475,975	419,530	419,530
R-squared	0.0017	0.0019	0.1558	0.1899	0.1428	0.1681
Year of Birth Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Birth Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Parental Characteristics	No	No	No	No	No	No
No. Clusters	61	61	61	61	61	61

Notes: OLS estimates of equation (2) reported in columns (1) (3) and (5). Province of birth and year of birth fixed effects included in every regression. Columns (2) (4) and (6) reports results from specification (3), in which each explanatory variable is interacted with an indicator for girl. Demographic characteristics in every specification include gender and relationship to household head. Standard errors clustered at the province level. * ** *** represents significance at the 10, 5, and 1 percent level, respectively.

TABLE B3: ESTIMATION ON GEOGRAPHIC SUBSAMPLES

	Urban		*Rural*		*Drop Kurdish Areas*	
Dependent Variable	Disabled	Literate	Disabled	Literate	Disabled	Literate
	(1)	(2)	(3)	(4)	(5)	(6)
VPD Prevalence*Post	-0.0003	0.0159*	-0.0004	0.0140***	-0.0006**	0.0079*
	(0.0004)	(0.0080)	(0.0003)	(0.0043)	(0.0002)	(0.0042)
Observations	204,720	204,638	137,477	137,458	311,695	311,606
R-squared	0.0026	0.1774	0.0023	0.1252	0.0022	0.1095
Year of Birth Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Birth Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Parental Characteristics	No	No	No	No	No	No
No. Clusters	30	30	31	31	56	56

Notes: OLS estimates of equation (2) reported on different geographic subsamples, including urban only (as classified in the 1985 census) rural only (the complement of urban). Kurdish are primarily in the Southeast ("Turkish Kurdistan") and includes the provinces of Agri, Batman, Bitlis, Mardin Hakkari, Siirt, Simak, Van and Diyabaker (corresponding to birth province numbers 4, 47, 13, 65 and 21). * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

TABLE B4: DHS SAMPLE (WOMEN ONLY)

Dependent Variable	Height	Years Education	Total Kids	Literate
	(1)	(2)	(3)	(4)
VPD Prevalence*Post	-0.0057	0.2601**	0.0267	0.0329**
	(0.0310)	(0.1178)	(0.0376)	(0.0144)
Observations	383	1,029	1,029	1,029
R-squared	0.2913	0.3113	0.4702	0.7365
Year of Birth FE	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
HH Characteristics	No	No	No	No
No. Clusters	53	58	58	58

Notes: OLS estimates of equation (2) reported above using the DHS individual recode file for women. Although province of birth is not provided across all waves, childhood province is recorded. I include women 19-23 in the 1993, 1998 and 2003 DHS, which is consistent with the 15-19 year old sample constructed using the census. Similar to the main results, I estimate the equation on those who remain in province of childhood to reduce measurement error in the treatment variable. Standard errors are clustered on the childhood province level. * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

TABLE B5: EFFECT OF DISABILITY ON LITERACY

Dependent Variable	Literacy	
	Boys	*Girls*
Disabled	-0.3031***	-0.3400***
	(0.0100)	(0.0145)
Observations	175,348	166,748
R-squared	0.1222	0.2428
Year of Birth Fixed Effects	Yes	Yes
Province FE	Yes	Yes
Parental Characteristics	Yes	Yes
No. Clusters	61	61

Notes: OLS estimates of literacy on disability as well as parental characteristics such as occupational status of father, mother's literacy and family size and demographic characteristics including relationship to household head. All regressions include birth province fixed effects and year of birth fixed effects. Standard errors are clustered at the province level. * ** *** represent significance at the 10, 5 and 1 percent level, respectively.

8.3 Appendix C: Comparative Cost Effectiveness Analysis

The economic costs of the campaign (including personnel and capital costs), approximately $30 million dollars, of which approximately $2.2 million was provided by agencies other than the Turkish government. The campaign distributed 27 million vaccinations, thus a cost of slightly more than a dollar per vaccine delivered. The reduction in mortality appears negligible. However, if this campaign was able to increase literacy rates of women by 3%, then **here compare to school uniforms and CCT**