Ethnic-religious Differences in Child Survival in Egypt*

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Abstract

Ethnic and religious differentials in infant and child mortality are observed in many countries. In Egypt during 1980s and 1990s, Christians have higher child mortality than Muslims despite their advantage in socioeconomic status. This paper explores reasons for the Christians-Muslim mortality gap. The comparison in child survival uses propensity score matching and survival analysis. Results indicate that differences in the regional distributions of Christians and Muslims positively contributed to the mortality gap during the 1980-90s. About 70% of Christians resided in Upper Egypt where childhood mortality rates were twice as high than in other regions. However, only part of excess Christian mortality can be explained by their higher concentration in Upper Egypt. The Christian mortality disadvantage–both nationally and in Upper Egypt–prevails irrespective of this group's socioeconomic advantage. These findings are at odds with research demonstrating the significance of socioeconomic status and urban concentration to ethnic-religious mortality gaps.

1 Introduction

In most countries in the Middle East, discussion of ethnic–religious health inequalities remains acutely scarce. Prevailing tensions between ethnic-religious groups throughout the region may discourage investigation of inequality along the lines of ethnic-religious affiliation. Egypt is no exception; while the relative size of the Christian Copt minority has become a source of significant controversy, health and mortality differentials between the Copt minority and Muslim majority are hardly mentioned.

In this paper, I investigate differences in child survival and nutritional status between the Christian minority and Muslim majority in Egypt. To the best of my knowledge, this is the first study to address this topic. I review studies of health gaps between ethnic-religious groups, including mortality gaps in Egypt, and results are discussed in light of the literature on ethnic-religious health gaps.

1.1 Mortality gaps between ethnic–religious groups

Ethnic and religious differentials in infant and child mortality are observed in many countries (e.g. Amitai et al. 2005; Brockerhoff and Hewett 2000; Caldwell 1990; Defo 1996; Guillot and Allendorf 2010; Preston et al. 1994; United Nations 1985). Reasons for these differentials may vary across countries but mostly cluster around three factors: socioeconomic differences, regional variations, and differences in cultural practices.

Mensch, Lentzner, and Preston studied infant and child mortality differentials in fifteen developing countries in Asia, Africa, and Latin America (United Nations 1985). They report that differences between ethnic and religious groups exist in almost all of these countries. In addition, they note that gaps are more prominent between ethnic than religious groups and in rural than urban areas [1]. Another large-scale, cross-national, comparative study was conducted by Brockerhoff and Hewett (2000), whose analysis of Demographic and Health Surveys (DHS) from the 1990s reveals significant disparities in early child survival among ethnic groups across a wide range of African countries (Central African Republic, Cote d'Ivoire, Ghana, Kenya, Mali, Namibia, Niger, Rwanda, Senegal, Uganda, and Zambia). This finding of large ethnic gaps encouraged the authors to "strongly support placing the notion of ethnicity at the forefront of the theories and analysis of child mortality in Africa, which incorporates social, and not purely epidemiological

[1] The study makes a clear distinction between religion and ethnicity that is not emphasized in other studies. For example, Brockerhoff and Hewett (2000) regard religion as a defining characteristic of ethnicity.

considerations" (Brockerhoff and Hewett 2000 :37).

Socioeconomic disparity may comprise the most common explanation for gaps in mortality between ethnic and religious groups. In cases where the ethnic-religious group with a higher mortality rate is likewise disadvantaged in social and economic terms, socioeconomic differentials become the immediate "natural" candidate for explaining the mortality gap. In fact, cases that do not fit this pattern are usually called "puzzles," reflecting researchers' strong propensity to propose socioeconomic difference as the principal exegetic factor. The tendency to associate health gaps with social differences is founded upon an elementary rationale: social status strongly affects health. Therefore, ethnic-religious differences in socioeconomic status (SES) are the most likely cause of health gaps. Empirically, this reasoning is broadly supported, with a significant portion of observed ethnic-religious mortality differences attributed to socioeconomic disparity (Brockerhoff and Hewett 2000; Burgard and Treiman 2006; Weeks 1988). In some cases, however, such support is only partial (United Nations 1985), that is, SES differences alone cannot fully account for health gaps between ethnic-religious groups.

A handful of cases challenge the socioeconomic interpretation showing higher mortality observed among the socially advantaged ethnic-religious group (e.g. Guillot and Allendorf 2010). In these cases, researchers usually fall back on variations between the studied groups in practices and attitudes relevant to child health. Usually, such practices are related to child rearing, hygiene, and sanitation. Associating religious-ethnic affiliation with a specific 'culture' of raising children should not be surprising. In settings where modern health-care is not fully prevalent, local and traditional knowledge play a significant role in childrearing (Caldwell 1990). Variations between religious-ethnic groups in this knowledge may account for some of the child survival differential.

Highlighting another possible link between religious affiliation and child survival, Caldwell (1986) point to the issue of women's autonomy. In particular, Caldewll hypothesized that constrained female autonomy could explain low achievement in child survival in some Islamic societies. Support for this hypothesis, however, was limited (Ghuman 2003; Brockerhoff and Hewett 2000; Kuhn 2010).

A third explanation behind ethnic-religious differences in mortality focuses on the geographic distribution of ethnic-religious groups[2]. Availability

[2]In relation to regional distribution, Poppel et al. (2002) posit social isolation as an explanation for gaps in infant mortality in Holland in the late nineteenth and early twentieth centuries. They argue that the social isolation of small religious groups and, in particular, the isolation of infants and children, reduced their exposure to infectious disease and may have contributed to lower infant and child mortality rates among these groups.

of health facilities and other resources could vary considerably across different regions within a single country. Compared to rural areas, urban centers are more likely to have advanced facilities, higher concentration of experts, and better infrastructure, including access to clean water, transportation and sanitation. When a specific ethnic-religious group is highly concentrated in an area with relatively poor health infrastructure or in an area characterized by high mortality, it may suffer from such disadvantages regardless of the socioeconomic attributes of its (individual) members.

While the preceding explanations are presented independent of one another, they may interact in several ways. Regional differences might reflect socioeconomic or cultural differences. For example, Defo (1996) explains that in the eastern region of Cameroon "... unhealthy practices related to childbirth ... such as cutting the umbilical cord with the peel of a sugar cane .. lead[s] to the highest rates of neonatal tetanus" (Defo 1996 :415). In general, when modern, standardized, medicine becomes accessible at a large scale, much of the traditional practices of child rearing begin to fade, a process that leads to some convergence in mortality rates across ethnic-religious groups and regions (Caldwell 1990). The observation by Mensch, Lentzner, and Preston of higher ethnic-religious gaps in rural than urban areas is highly related (United Nations 1985). Modernity arrives first to urban centers, reducing ethnic-religious gaps there before spreading outward to rural areas where ethnic-religious gaps may persist.

In a pre-modern medical era, ethnic-religious gaps may result from a combination of cultural and socioeconomic factors. With the expansion of modern health care systems, cultural differences may subside, with socioeconomic differences still contributing to health and mortality inequalities. The following section discusses these factors in relation to the case study, namely, gaps between Copts and Muslims in Egypt.

1.2 Mortality gaps in Egypt

Even before the early 20th century, Christians in Egypt demonstrated lower mortality than Muslims (Courbage and Fargues 1997). The Nile Delta and Upper Egypt, where Christians represent more than 10% of the total population, were also the provinces with the lowest infant mortality. By 1920, however, this regional correlation has disappeared. "... [F]rom 1944 the statistics give mortality rates by religion, demonstrating a higher [crude death] rate among Muslims which persisted in independent Egypt. Over time, however, the difference between the two communities was reduced ... as very high mortality rates fell overall, the advantage of the Christians over the Muslims diminished, apparently disappearing during the 1970s" (Courbage and

Fargues 1997 :177).

Results from Adlakha et al. (1983) imply that the 1970s comprised a turning point in the Christian-Muslim gap. They estimate that the risk of neonatal and infant deaths are, respectively, 1.6 and 1.22 times greater for children of Christian mothers than for children of Muslim mothers. These estimations utilize data from the 1980 World Fertility Survey (WFS) and are based on regression models that account for demographic and socioeconomic differences between the two religious groups. Unfortunately, Adlakha et al. (1983) do not provide any explanation for the Christian disadvantage. Other sources about religious mortality differentials in Egyptian society could not be located, as contemporary studies about child mortality in Egypt deal almost exclusively with national trends or regional and socio-economic differentials with no concern for religious-ethnic gaps.

Since the 1980 WFS survey, eight DHS surveys have been conducted in Egypt. Five of these (1988, 1992, 1995, 2003, and 2008) asked respondents about their religious affiliation and thus provide insight into religious differences in infant and child mortality. Figure 1 presents under-five rates by religious group and table 1 presents neonatal, post-neonatal, infant, child and under-five mortality rates for Muslims and Christians in addition to absolute and relative differences in these measures between the two religious groups. In the early 1980s, under-five mortality among Copts was 129 deaths per 1000 births, compared to 100 deaths per 1000 births for Muslim—a gap of 29 deaths per 1000 births. In spite of mortality reduction, similar gaps are observed in the 1992 and 1995 surveys. The 1992 survey estimates under-five mortality for Copts at 114 deaths per 1000 births, compared to 83 deaths per 1000 births among Muslims—a gap of 31 deaths per 1000 births. The estimated gap using the 1995 survey is 28 deaths per 1000 births: 107 for Copts, versus 87 for Muslims. The absolute gap has been drastically reduced, as evidenced by more recent surveys in 2005 and 2008. A similar trend in the Copt-Muslim mortality gap persists when examining other mortality measures, such as infant mortality (see table 1).

This pattern of ethnic-religious difference in early childhood mortality raises two questions. First, what are the reasons for higher Christian mortality during the 1980s and early 1990s? Second, why did the Christian-Muslim gap disappear later on? The reviewed theoretical explanations suggest that the Christian-Muslim gap could have resulted from differences in the groups' socioeconomic status, regional distribution, or cultural practices.

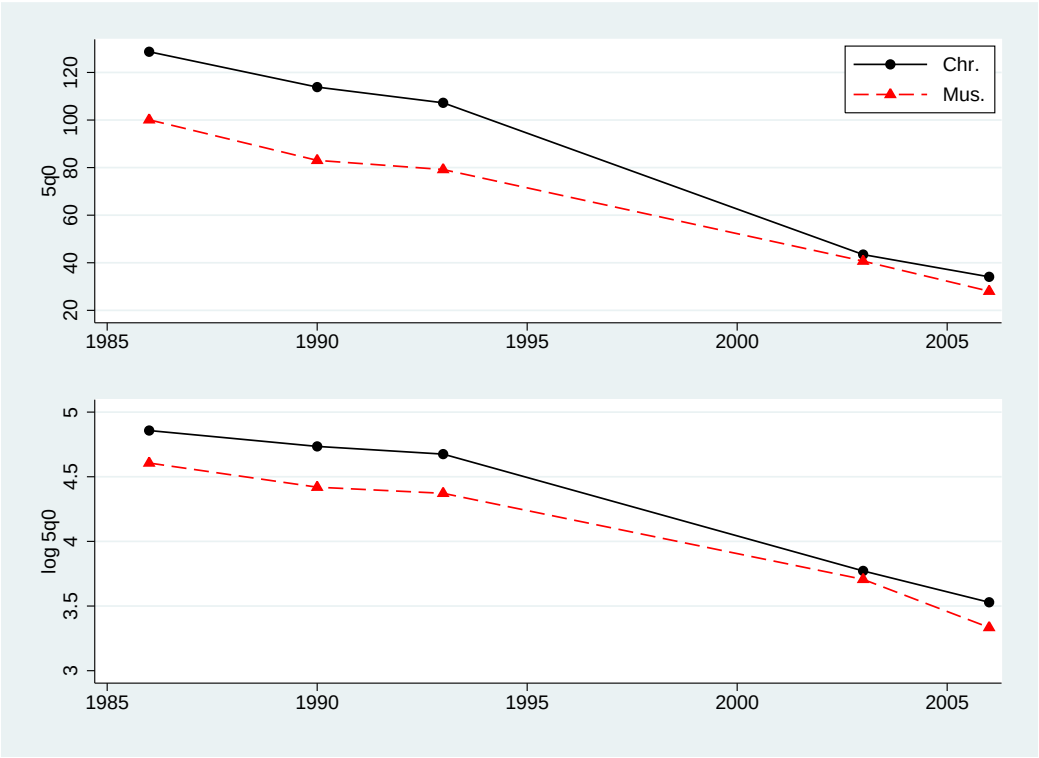
A distribution of select socioeconomic indicators, including maternal and paternal educational levels, fathers' occupational category, and household wealth among each religious group are presented in Table 2. In the period 1988-95, Christian mothers attained higher levels of education than their

Table 1: Neonatal (NN), postneonatal (PNN), infant, child, and under-five mortality rates for both sexes, by religious group, Egypt 1988-08

	NN	PNN	Infant	Child	Under-five
Survey year	Christians				
1988	51	56	103	29	129
1992	43	43	85	31	114
1995	34	51	84	26	107
2005	23	13	35	8	43
2008	14	17	30	4	34
	Muslims				
1988	37	35	72	31	100
1992	32	29	60	25	83
1995	30	32	62	19	79
2005	20	14	33	8	41
2008	17	8	24	4	28
	Absolute difference				
1988	13	20	32	-3	29
1992	11	14	25	7	31
1995	4	19	22	8	28
2005	3	-1	2	0	3
2008	-3	8	6	0	6
	Ratio				
1988	1.4	1.6	1.4	0.9	1.3
1992	1.3	1.5	1.4	1.3	1.4
1995	1.1	1.6	1.4	1.4	1.4
2005	1.1	1.0	1.1	1.0	1.1
2008	0.8	2.0	1.3	1.0	1.2

Note: Rates are based on births only in the five-year period preceding each survey

Figure 1: Trends in under-5 mortality in arithmetic (upper) and log (lower) scales, by religious group, 1985-2008



Muslim counterparts. Christian fathers have modestly higher representation in professional jobs but do not show a significant educational advantage over Muslim fathers. A measure of household wealth, available only in recent surveys, indicates that on average, Christian households are wealthier than Muslim ones. In this study, I examine the contribution of socioeconomic and regional differences to the Copt-Muslim mortality gap.

Throughout the 1990s and 2000s, improved education among Christian and Muslim mothers, coupled with higher rates of mobility among Muslim mothers, helped narrow gaps between the two groups. Trends in paternal education are similar. Regarding occupational attainment, both groups demonstrate increased professional participation and agricultural employment was nearly halved. In the period 1988-95, Christians generally enjoyed a socioeconomic advantage over Muslims. As a result of improved Muslim mobility, however, this advantage was smaller in 2005-08. Based on the described socioeconomic indicators, survival rates are predicted to be higher among Copts than Muslims, especially in the earlier period.

Regional distributions of Christians and Muslims are presented in Table 3. Changes in the geographic distribution of each group between the periods 1988-95 and 2005-08 are minor. In the first period, 49% of Christians lived in urban areas, compared to 41% of Muslims. In the second period, 51% of Christians lived in urban areas, compared to 37% of Muslims. The higher urban concentration contributed to a mortality advantage for Christians, as mortality is significantly lower in urban than rural areas (El-Zanaty and Way 2009).

Christians are highly concentrated in Upper Egypt, a region characterized by higher mortality rates than elsewhere in Egypt. In 1992-2005, under-five mortality rates in Upper Egypt comprised 112 deaths per 1000 births compared to 63 per 1000 births deaths in all other regions combined. Despite significant reduction, regional mortality differentials persist in the period 2005-08. In Upper Egypt, under-five mortality is as high as 41 deaths per 1000 births, compared to 28 deaths per 1000 births in the other regions.

To conclude, the Christian mortality disadvantage of 1988-95 persists despite this group's moderate advantage over Muslims in socioeconomic status (SES) and higher concentration in urban areas. Higher Copt mortality, it would seem, is principally a function of this group's geographic concentration in Upper Egypt. In 2005-08, the socioeconomic advantage of Christians decreases while their regional and urban concentration remain largely the same. The absence of a mortality gap during the 2000s might reflect a balance between Copt advantages and disadvantages in addition to a general reduction in all absolute mortality differentials.

Table 2: Distribution of socioeconomic indicators by religious group, Egypt 1988-2008

	1988-95		2005-08	
	Mus.	Chr.	Mus.	Chr.
Mother's education				
No education	48	42	30	28
Primary	25	22	12	8
Secondary	23	27	48	50
Higher	5	10	10	13
Husband's education				
No education	31	30	18	17
Primary	32	30	17	14
Secondary	27	28	50	54
Higher	10	12	14	15
Husband's occupation				
Professional	15	19	23	25
Agriculture	28	31	17	16
Manual	27	23	36	38
Other	30	27	24	21
Household wealth quintile[a]				
Poorest	na	na	23	22
Poorer	na	na	21	17
Middle	na	na	20	16
Richer	na	na	19	20
Richest	na	na	17	25
Mean	na	na	-14,989	2,134
Std.	na	na	718	3,644

[a] Wealth index was not available (na) in the 1988-95 surveys

Table 3: Regional distribution of Copts and Muslims, Egypt 1988-2008

	1988-95		2005-08	
	Mus.	Chr.	Mus.	Chr.
Type of residence				
Urban	41	49	37	51
Rural	59	51	63	49
Region				
Lower Egypt	36	9	34	9
Upper Egypt	41	69	46	73
Urban governorates[a]	19	21	15	15
Frontier governorate[b]	4	1	5	3
Region and residence				
Urban governorates[a]	19	21	15	15
Lower Egypt - urban	10	7	8	5
Lower Egypt - rural	26	2	26	4
Upper Egypt - urban	10	21	12	27
Upper Egypt - rural	31	48	35	45
Frontier governorate[b]	4	1	5	3

[a] Urban governorates include the major cities: Cairo, Alexandria, Port Said, and Suez
[b] Located on the eastern and western boundaries of Egypt

1.3 Nutritional status differences

Nutritional status is an objective measure of children's overall health and well-being. When mortality rates among infant and children are relatively low, measures of nutritional status provide a complementary measure of the health of those who survive. Under-nutrition is a consequence mainly of inadequate food intake and repeated, improperly treated illness (Sommerfelt and Stewart 1994). Undernutirition risk factors serve generally as risk factors for mortality as well; undernourished children are at greater risk of death than well-nourished children.

Table 4: Percent stunted and Copt-Muslim differece in percent stunted, children ages 2–5 years, by religious group and survey

Survey	Copts	Muslims	Difference
1992	16.8	19.7	-2.8
1995	29.8	25.3	4.5
2005	21.3	17.8	3.5
2008	25.8	22.6	3.2

Note: The 1988 survey is not included because it is missing nutritioal data for children ages 4-5 years and it has a relatively large number of missing values

A common index of nutritional status is height-for-age, which "... reflects a child's stature in relation to his or her age. A low score is evidence of chronic under-nutrition, in which past insults and deficiencies have caused short stature." (Sommerfelt and Stewart 1994 :4). The height-for-age index is usually expressed in Z-scores defined as the deviation from the median of a reference population[3] A deviation of -2 standard units from the median of the reference population is used as a cutoff point. Children whose height-for-age measures are below this figure (-2 SD) are considered short for their age or stunted (El-Zanaty and Way 2009 :chap. 14).

Table 4 compares Christian and Muslim children in percent stunted. In contrast to the 1992 survey, in which Copt children showed less stunting

[3]DHS surveys prior to 2008 used as a reference the population defined by the U.S. National Center for Health Statistics (NCHS) and accepted by World Health Organization (WHO) and the U.S. Center for Disease Control (CDC). Starting from 2008, DHS indicators are compared against new growth standards generated by the WHO from data collected in a Multicentre Growth Reference Study (World Health Organization 2006). In this study, I use the old reference for all surveys, including the 2008 survey.

than Muslims, in the 1995, 2005, and 2008 surveys, Copts had 3–4% higher stunting rates than Muslims.

To summarize, the mortality and nutritional status of Copt children (more clearly regarding mortality) indicate that they have lower health than Muslim children. These observed gaps contradict the predictions stemming from higher Copt SES and geographic concentration in urban areas. This regional disadvantage may relate to living conditions in Upper Egypt. The following analysis investigates gap changes when controlling for SES and regional differences. Because of the centrality of the regional distribution, I also analyze the gap in Upper Egypt in particular.

2 Methods

2.1 Data

Data for this study is drawn from Egypt's 1988, 1992, 1995, 2005 and 2008 DHS surveys. Each includes a variable describing the religious-ethnic affiliation—Christian or Muslim—of the respondent. The analytical sample includes only mothers who had at least one birth in the five years preceding the interview. Table 5 presents the number of women and births by religion across the five surveys.

2.2 Analysis

The main analysis compares children of Copt and Muslim mothers in under-five mortality and in nutritional status using propensity score matching. The propensity score is defined as the probability of being a Copt mother given background (matching) variables. Copt mothers are matched to Muslim mothers on the estimated propensity score using the *pairmatch* function. Matching is implemented separately for each survey.

The matching variables include: region, type of residence, mother's age, mother's years of schooling, husband's years of schooling, husband's occupation, and household wealth. In the 1988, 1992 and 1995 surveys, household wealth is measured by ownership of a radio, television, refrigerator, and connection to electricity, as well as household's source of drinking water, type of toilet facility, and floor material. The recent 2005 and 2008 surveys provide a composite measure of household wealth.

Mortality is measured by child survival to the age of five. Differences between children of Copt mothers and children of all or matched Muslim mothers in survival to age five are tested using Cox regression models. Nutritional status is measured by the height-for-age Z-score and percent stunted.

Table 5: Numbers of mothers and births by religious group and survey

Survey	Muslims	Christians	Total
		Mothers	
1988	4,986	296	5,285
1992	5,425	293	5,721
1995	7,590	430	8,025
2005	9,527	452	9,981
2008	7,683	349	8,035
Total	35,211	1,820	37,047
		Births	
1988	8,182	464	8,646
1992	8,412	451	8,863
1995	11,541	657	12,198
2005	13,259	627	13,886
2008	10,446	460	10,906
Total	51,840	2,659	54,499

Analysis is limited to children aged 2-5 years, and does not include cases from the 1988 survey, which only collected nutritional data from children aged 0-3 years and has a relatively high number of missing values. The comparison of means of Z-scores uses the t-test and the Wilcoxon rank sum test. The comparison of percent stunted uses a logistic model, which predicts the probability of being stunted given religious affiliation.

Because of the higher concentration of Copts in Upper Egypt (about 70%), a factor ostensibly central to their mortality disadvantage, a separate analytical set is applied for cases from Upper Egypt.

Because the relatively small number of total Copt births, I conduct power analysis for detecting significant differences in survival. The power analysis uses the *stpower cox* function in Stata. For each survey, it calculates the sample size required to detect, with 80% power, the expected Copt-to-Muslim hazard ratio (see table 6). The expected hazard ratio is based on the ratio of the calculated under-five death rates presented in table 1. Table 6 also provides a calculation of the achieved power given the actual sample size and the minimal effect size (in units of hazard ratio) that can be detected with power 80% given the actual sample size. For every survey, results show that the actual sample size is less than that required to detect the expected gap in survival, the calculated actual power is considerably less than 80%, and the gap which can be detected (with 80% power) given the actual individual samples is higher than the expected gap based on the observed death rates.

Given the power calculation results, I combine the 1988, 1992, and 1995 surveys into a single sample and the 2005 and 2008 into another. Combining matched surveys from different years amounts to exact matching on survey-year and does not require any further matching. The combined samples are also used to analyze nutritional differences, although the aforementioned power limitation does not apply for measures of nutritional status.

3 Results

Matching resulted in a high degree of overlap between the two comparison groups, as indicated by the distributions of the estimated propensity score for all Copts, all Muslims and matched Muslims (see Figure 2). Formal statistical tests (not presented) did not detect significant difference between Copt mothers and matched Muslim mothers in any of the matching variables. In addition, matching balanced the two groups in birth characteristics including birth order, preceding birth interval, year of birth, and sex of child. First, I report mortality gradients by region, education, and urban concentration. I then report the comparison of the matched samples in child survival and

Table 6: Required sample size, actual test power, and minimal detected effect for individual and combined surveys

Survey	Death ratio	Expected hazard ratio	Sample size *Actual*	*Required*	Actual power	Minimal detected effect *Unmat.*[a]	*Mat.*[b]
1988	1.29	1.3	8,646	18,550	0.52	1.47	1.70
1992	1.37	1.3	8,863	23,182	0.46	1.53	1.79
1995	1.35	1.3	12,198	23,024	0.57	1.43	1.64
1988-95	1.34	1.3	29,707	21,313	0.90	1.25	1.36
2005	1.05	1.1	13,886	183,371	0.36	1.66	2.02
2008	1.21	1.1	10,906	282,326	0.23	2.04	2.68
2005-08	1.12	1.1	24,792	222,577	0.47	1.52	1.78

[a] Unmatched sample
[b] Matched sample

finally, the comparison in nutritional status.

3.1 Child survival

Table 7 presents under-five mortality gradients by maternal education (*primary or less vs. secondary or higher*), type of residence (*urban vs. rural*) and region (*Upper Egypt vs. other regions*). In the all-regions, 1988-95 survey, rural mortality exceeds urban mortality by 53 deaths per 1000 births, mortality among the least educated exceeds that among the most educated by 54 deaths per 1000 births, and mortality in Upper Egypt exceeds that in the other regions by 48 deaths for every 1000 births. In about two decades, all of these gradients fall off drastically. In the 2005-08 survey, the gap between the least and most educated falls to about 15 deaths per 1000 births, the gap between Upper Egypt and the other regions narrows to 13 deaths per 1000 births, and the gap between rural and urban areas almost disappears.

Table 7 also shows that in Upper Egypt during the 1980-90s the Copt minority has higher under-five mortality (134 deaths per 1000 births) than the Muslim population residing in the same region (111 deaths per 1000 births). This excess Copt mortality is not observed in the other regions. The result implies that factors other than geographic concentration in Upper Egypt likely contribute to higher Copt mortality.

Differences in child survival between Copt and Muslim children before and after matching are presented in table 8. In the 1988-95 combined sample, the hazard of dying within the first five years is 27% higher for Copts

Figure 2: Distribution of propensity score for all Christians (Chr.), all Muslims (Mus.) and matched Muslims (M. Mus.), by survey

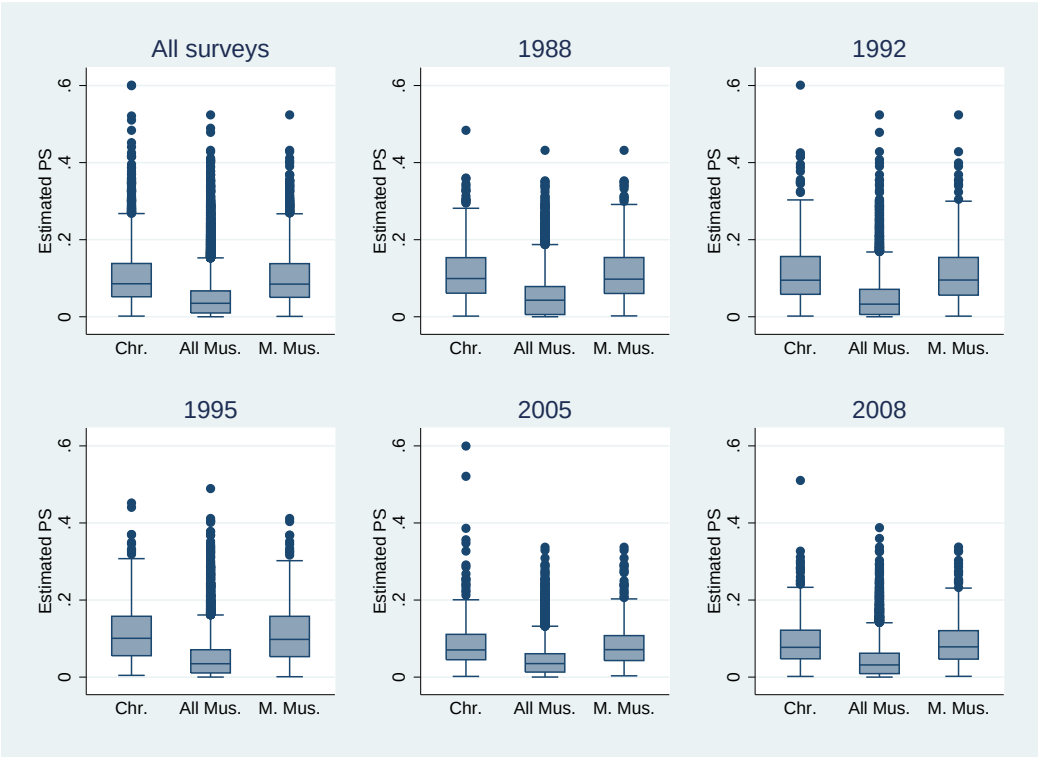


Table 7: Socioeconomic and regional under-five mortality gradients, by survey, region, and religious group

	1988-95			2005-08		
	Chr.	Mus.	Total	Chr.	Mus.	Total
	All-regions					
Type of residence						
Urban	73	57	58	31	34	33
Rural	148	98	101	40	34	34
Education						
Primary or less	145	95	98	41	43	43
Secondary or higher	46	43	44	32	28	28
Region						
Upper Egypt	134	111	112	35	41	41
Other regions	63	63	63	36	28	28
	Upper Egypt					
Type of residence						
Urban	80	75	76	18	39	38
Rural	155	123	125	44	42	42
Education						
Primary or less	156	118	120	50	36	37
Secondary or higher	63	70	70	23	24	24

than for Muslims (hazard ratio=1.27, p< 0.01). After matching, the Copt-Muslim mortality gap is substantially reduced (hazard ratio=1.05, p> 0.05). This result is further demonstrated by the absolute under-five mortality rates for Copts, all Muslims, and matched Muslims presented in figure 3. Matching reduced the mortality gap from 30 to 10 deaths per 1000 births. Notice that matching amounts to selection on higher mortality, that is, under-five mortality for matched Muslims equals 103 deaths per 1000 births compared to 83 deaths per 1000 births for all Muslims. In fact, matching selects, at varying degrees, on SES, urban concentration and regional distribution, or simultaneously accounts for Copt mortality advantages (higher SES and higher urban concentration) and disadvantage (higher concentration in Upper Egypt). Because differences in regional distribution are the largest, in addition to a strong regional mortality gradient, the regional disadvantage outweighs both SES and urban residence advantages and the net result of matching on these three variables amounts to matching on higher mortality.

If the main disadvantage of the Copt minority originates in its higher concentration in Upper Egypt, controlling for this factor should result in lower mortality rates among the minority, owing to the minority's SES and urban residence advantages. Results from the Upper Egypt, pre-matched sample do not support this prediction (hazard ratio=1.08, p > 0.05). In fact, the Copt minority in Upper Egypt has higher under-five mortality (134 deaths per 1000 births) than the Muslim population of the same region (111 deaths per 1000 births). First, notice that the pre-matched gap in Upper Egypt (23 deaths per 1000) is smaller than that of the national sample (30 death per 1000 births), which indicates a positive contribution of regional concentration to the Copt-Muslim gap. Nonetheless, the gap in Upper Egypt does not indicate lower mortality among Copts, as expected. Furthermore, unlike the all-regions sample, matching in the Upper Egypt sample is expected to select on lower mortality (among Muslims) because it selects mainly on higher SES and urban concentration. Results, however, show the opposite: the rate among matched Muslim children (123 deaths per 1000 births) exceeds that among all Muslim children (111 deaths per 1000 births).

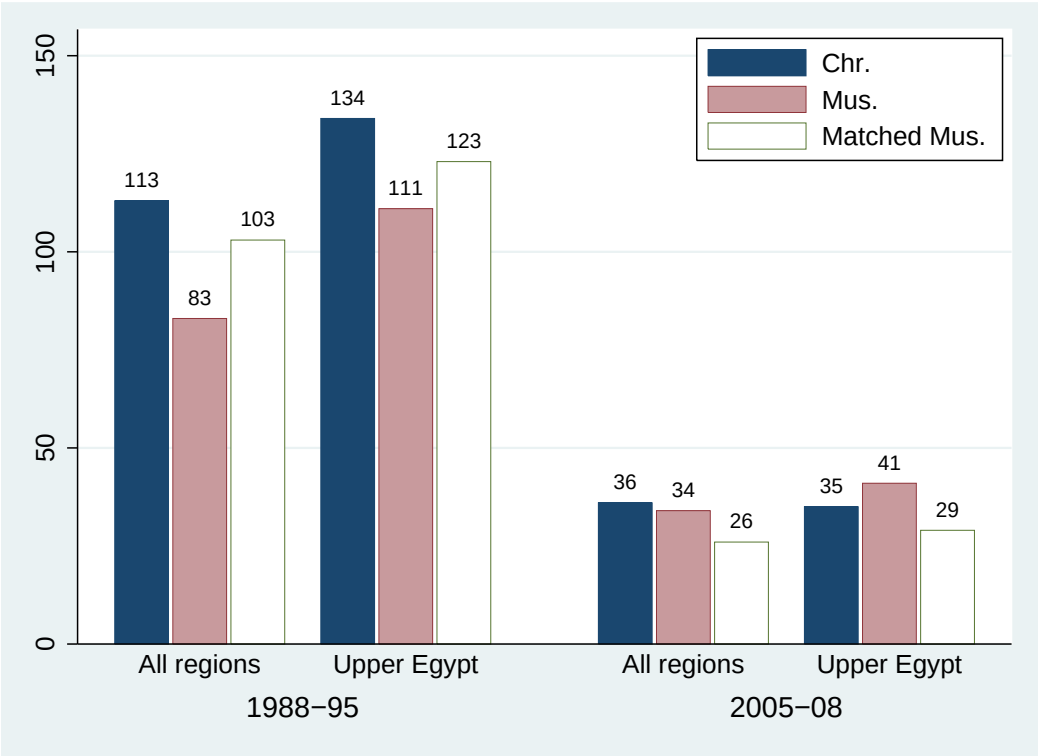
In the 2005-08 survey, the pre-matching Copt-Muslim gap is insignificant. Because of a drastic reduction in Egyptian mortality, regional and socioeconomic differentials—as well as their contribution to the Copt-Muslim mortality gap—become relatively small. In the matched sample, the estimated gap indicates a higher risk of death among Copts, though it lacks statistical significance (hazard ratio=1.35, p > 0.05)[4]. In terms of absolute death

[4]According to the power analysis in table 6, the minimum hazard ratio that can be detected based on the 2005-08 sample is 1.78. That is, even when the estimated gap

Table 8: Estimated Copt-to-Muslim hazard ratios and 95% confidence intervals (CI) of dying before age five, in all regions and in Upper Egypt

Survey	Sample	Hazard ratio	95% CI	P-value
		All regions		
1988-95	Unmatched	1.27**	(1.07–1.50)	0.007
	Matched	1.04	(0.82–1.31)	0.764
2005-08	Unmatched	1.03	(0.74–1.45)	0.843
	Matched	1.35	(0.82–2.23)	0.241
		Upper Egypt		
1988-95	Unmatched	1.08	(0.89–1.31)	0.435
	Matched	1.01	(0.78–1.31)	0.928
2005-08	Unmatched	0.83	(0.55–1.24)	0.350
	Matched	1.16	(0.66–2.06)	0.603

Figure 3: Under-five mortality rates among Copts, Muslims, and matched Muslims



rates, Copts have higher under-five mortality (36 deaths per 1000 births) than matched Muslims (26 deaths per 1000 births). Notice that matching increases the gap, which indicates that the negative (suppressing) contribution of higher Copt SES and urban concentration to the total gap outweighs the positive contribution of this group's regional concentration in Upper Egypt.

Restriction of the 2005-08 sample to cases from Upper Egypt yields insignificant differences in the risk of dying neither in the pre-matched sample (hazard ratio=0.83, $p > 0.05$) nor in the matched sample (hazard ratio=1.16, $p > 0.05$). In terms of absolute death rates, accounting for SES, urban and regional concentrations (through matching), broadens the mortality gap: a negative gap of 6 deaths per 1000 births between Copts and all Muslims increases to a positive gap of 6 deaths per 1000 births between Copts and matched Muslims.

3.2 Nutritional status

The final analysis compares Copt and Muslim children aged 2-5 years in two nutritional status measures: height-for-age Z-scores and percent stunted. In the combined, pre-matched 1992-95 survey, no significant differences in height-for-age or percent stunted are observed (see tables 9 and 10). After matching, the difference in height-for-age becomes significant (t=2.03, $p< .05$) and the difference in percent stunted is significant at the 0.10 level. In the Upper Egypt 1992-95 sample, differences in height-for-age and stunting are not significant. In general, compared to the other regions, nutritional status in Upper Egypt is lower and nutritional gaps between Copts and Muslims are smaller.

Results from the 2005-08 survey indicate that Copts have lower height-for-age Z-scores (t=2.86, $p< .01$) and higher odds of being stunted (odds ratio=1.22, $p< .01$) (see tables 9 and 10). The difference in height-for-age remains significant after matching (t=2.86, $p < .01$), while the difference in percent stunted become statistically insignificant at the 0.05 level. No significant differences are observed in the Upper Egypt sample.

To summarize, from 1988-95, the mortality gap observed in the pre-matched sample is almost entirely eliminated when comparing Copts and Muslims with similar SES and regional concentration, i.e. in the matched samples. Limiting the analysis to Upper Egypt, where most Copts reside, reduces the pre-matched gap, which indicates a significant contribution of regional concentration to their mortality disadvantage relative to the overall Muslims population. At the same time, even in Upper Egypt, Copts have

reflects a real difference, it cannot be detected in this sample.

Table 9: T-test results of Copt-Muslim differences in height-for-age Z-scores

Group	N	Mean	s.d.	diff.	t-value	p-value
1992-95, All regions						
Christians	583	-127.3	6.4			
Muslims	10,278	-119.0	1.6	-8.3	1.25	0.106
Matched Muslims	603	-108.8	6.5	-18.5	2.03	0.022
1992-95, Upper Egypt						
Christians	444	-138.9	7.5			
Muslims	4,597	-134.8	2.4	-4.1	0.33	0.370
Matched Muslims	475	-132.6	7.1	-6.3	0.30	0.380
2005-08, All regions						
Christians	592	-109.7	7.2			
Muslims	12,234	-88.7	1.5	-21.0	2.86	0.002
Matched Muslims	626	-90.4	6.4	-19.2	2.00	0.023
2005-08, Upper Egypt						
Christians	436	-112.8	8.0			
Muslims	5,868	-110.1	2.0	-2.7	0.33	0.370
Matched Muslims	468	-109.5	7.4	-3.3	0.30	0.380

Table 10: Copt-to-Muslim odds ratios and 95% confidence intervals (CI) of being stunted, in all regions and Upper Egypt

Sample	Odds ratio	s.d.	95% CI	z	p-value
All regions, 1992-95					
Unmatched	1.10	0.10	(0.92–1.31)	1.03	0.30
Matched	1.27	0.16	(0.99–1.63)	1.91	0.06
All regions, 2005-08					
Unmatched	1.22	0.11	(1.02–1.47)	2.15	0.03
Matched	1.19	0.16	(0.92–1.53)	1.29	0.20
Upper Egypt, 1992-95					
Unmatched	1.02	0.10	(0.84–1.24)	0.22	0.83
Matched	1.16	0.16	(0.89–1.53)	1.10	0.27
Upper Egypt, 2005-08					
Unmatched	1.07	0.12	(0.86–1.33)	0.60	0.55
Matched	1.06	0.16	(0.78–1.42)	0.36	0.72

higher mortality than Muslims, which is unexpected given their higher SES and urban concentration within this region.

In the period 2005-08, the Copt-Muslim mortality gap has declined to a low level of about 2 deaths per 1000 births. Since mortality rates are still higher in Upper Egypt (0q5=63) compared to the other regions (0q5=28), the regional disadvantage of Copts persists, alongside moderate SES and urban concentration advantages. The absence of a sizeable Copt-Muslim mortality gap thus reflects a balance between Copt advantages and disadvantages in addition to relatively weaker socioeconomic and regional gradients. In Upper Egypt, where Copts show moderate SES advantages, their mortality rates are slightly lower than those of Muslims.

While the mortality gap has disappeared during the 2000s, measures of nutritional status point to a lower status among Copt children. These differences are only partially reduced when Copts are compared with matched Muslims. Part of this nutritional gap is attributable to concentration of Copts in Upper Egypt, as indicated by the absence of significant gaps within this region.

4 Discussion

Census data from early 19th century Egypt show that, compared to Muslims, Christians enjoyed lower mortality rates, including infant and child mortality (Courbage and Fargues 1997). Surveys from the 1980s and early 1990s point to higher childhood mortality among the Christian minority. As mortality has dramatically declined among both Christians and Muslims, as shown in the 2005 and 2008 DHS surveys, so too has the absolute Christian-Muslim mortality gap. This paper explores reasons for the Copt-Muslim mortality gap observed during the 1980s and 1990s. In addition, a supplementary analysis examines differences between Christians and Muslims in nutritional status—another objective measure of health and well-being. To the best of my knowledge, this is the first study to address Christian-Muslim gaps in child mortality in Egypt.

Previous research has posited three central explanations for ethnic-religious gaps in health and mortality: socioeconomic status, regional distribution, and cultural differences. This study tests the first and second hypothesis with regard to the Copt-Muslim mortality gap. Because the DHS surveys used in this study do not offer clear, defined measures for cultural differences, the third explanation is discussed only theoretically.

In Egypt during the 1980s and early 1990s, under-five mortality was high, ranging between 80-100 deaths per 1000 births (El-Zanaty and Way

2009). Three DHS surveys from this period recorded the religion-ethnicity of the respondents, thereby enabling estimation of religious-ethnic gaps. In comparison with Muslims, results show elevated childhood mortality among Christians. Specifically, excess under-five mortality among Christians reaches about 30 deaths per 1000 births. This estimated Christian-Muslim gap is consistent with previous reports based on the 1980 WFS (Adlakha et al. 1983).

The results indicate that differences in the regional distributions of Christians and Muslims positively contributed to the mortality gap during the 1980s and early 1990s. About 70% of Copts resided in Upper Egypt where under-five mortality rates were twice as high than in other regions (112 death per 1000 births vs. 63 death per 1000 births). However, the results show that only part of excess Copt mortality can be explained by this group's higher concentration in Upper Egypt. Restriction of the analysis to Upper Egypt, which rules out the regional effect without accounting for socioeconomic differences, shows that the Copt minority continues to show higher mortality relative to the Muslim majority. In other words, the majority of Copts reside in a region characterized by high levels of child mortality and in this region, they have elevated child mortality relative to the Muslim population. This results are puzzling given that the Copt minority has enjoyed higher socioeconomic status, as well as greater urban residence not only at the national level, but also within Upper Egypt.

Socioeconomic differences between Copts and Muslims are not likely the cause of the observed Copt-Muslim mortality gap. In fact, according to the socioeconomic indicators used in this study, Copts are expected to have lower mortality rates than Muslims. Similar reasoning applies to high urban concentration of Copts, which likewise predicts lower relative mortality among this group. Yet the Copt mortality disadvantage—both nationally and in Upper Egypt—prevails irrespective of this group's socioeconomic advantage. These findings are certainly at odds with a significant body of research demonstrating the significance of socioeconomic status and urban concentration to ethnic-religious mortality gaps (United Nations 1985; Brockerhoff and Hewett 2000).

Because regional differences only partially account for the Copt-Muslim mortality gap (and socioeconomic differences are not part of the explanation), one may posit cultural differences as a possible cause of the observed mortality gap. It is important to mention, however, that this study did not directly test for cultural differences between Copts and Muslims. Thus it cannot provide empirical evidence regarding the possible contribution of cultural differences to the studied mortality gap. Yet previous research has explored cultural differences as a factor in regional mortality differences, specifically,

"stronger persistence in Upper Egypt of practices that affect detrimentally the health of the mother and child during pregnancy, at delivery, and during early infancy. Of particular relevance would be avoidance of pre- and postnatal care provided by midwives-nurses with modern training, the cutting of the umbilical cord with unsanitary implements, potentially harmful postnatal practices (e.g., the practice of not washing the newborn for at least 7 days), and a host of behaviors grounded in traditional theories of illness ..." (Casterline et al. 1989 :30). While these factors may partially explain higher mortality in Upper Egypt, no evidence is provided to suggest that such practices are more prevalent among Copts than Muslims.

Between 1988-95 and 2005-08, a drastic decline in infant and child mortality is witnessed at the national level. The higher levels of 80-100 deaths per 1000 births during the 1980-90s had dropped to less than 35 deaths per 1000 births in the 2000s. Many attribute this decline to the National Control of Diarrheal Disease Project (1980-91) (El-Rafie et al. 1990), though others have demonstrated that diarrhea remained a leading cause of death among infants and children (Langsten and Hill 1995; Yassin 2000). Regardless the reasons, absolute and relative mortality differentials—including regional and religious gaps—declined. The Copt-Muslim gap of about 30 deaths per 1000 births during the 1980s and 1990s nearly disappeared (to around 2 deaths per 1000 births) in 2005-08. Over the same period, maternal education increased for Copts and Muslims, albeit with higher increases among Muslims. These trends reduced the relative socioeconomic advantages of Copt mothers. On the other hand, changes in the regional distribution of the two groups are less remarkable. That is, Copts' regional concentration disadvantage and urban residence advantage both persist. A balancing effect in the contribution of these opposing factors likely explains the absence of a sizable gap.

Another health outcome analyzed in the this study is nutritional status. When infant and child mortality rates are relatively low, measures of nutritional status provide a complementary measure of surviving child health. While the mortality gap disappeared during the 2000s, measures of nutritional status point to a lower status among Copt children. As with the mortality gap two decades prior, part of this nutritional gap is contributed by Copts' concentration in Upper Egypt, which is generally characterized by lower nutritional status.

Finally, this study documents a mortality gap not mentioned in the literature of ethnic-religious mortality gaps. It concludes that the central mortality disadvantage of Copts stems from their relatively higher concentration in Upper Egypt. However, this disadvantage cannot explain the total mortality gap—there are likely additional contributing factors. While the mortality gap has disappeared in the preceding decade, there is a weak indication of a

nutritional gap between Copts and Muslims. Additional research is required to uncover the extent of this nutritional gap and identify related contributing factors.

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