

IMPACTS OF PRENATAL RAMADAN EXPOSURE  
ON OUTCOMES IN ADULTHOOD : EVIDENCE  
FROM INDONESIA

A Thesis

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by

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## ABSTRACT

This paper presents reduced-form estimates of the impact of prenatal shocks on adult outcomes. The widespread fasting during the Islamic holy month of Ramadan is utilised as a natural experiment in order to estimate the impact of a relatively mild shock to individuals during gestation on socio-economic, education and health outcomes in adulthood. Previous literature shows that Ramadan observance during pregnancy is both common and detrimental to fetal health.

Using the fourth-wave of the Indonesian Family Life Survey, individuals in adulthood are estimated to earn 11.4% less and have 3.8% less years of education if the month of Ramadan overlapped in full with the first trimester of gestation. The impact of the effect remains significant for the second and third trimester of gestation but declines in magnitude. Height and weight in adulthood are also found to be significantly lower for men, but this does not hold for women. The contrast in results between these biological indicators and economic outcomes suggests that there may be significant differences in compensating investment by gender.

The channels of effect for the main results remains largely unknown, but there is little evidence to suggest that differing levels of physical health and/or mental cognition are the key channels of effect. These results suggest that the impacts of even a mild prenatal shock may be significant and persistent, but also relatively subtle in their expression.

## **BIOGRAPHICAL SKETCH**

Min-Taec Kim received his undergraduate education at the University of Sydney, completing a Bachelor of Economics and Social Sciences in 2009. At the University of Sydney, Min-Taec worked as part of the academic staff, assisting with the teaching and administration of the first-year program in Economics.

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## CHAPTER 1

### INTRODUCTION

The idea that shocks that occur early in life radically impact outcomes in adulthood has critical implications for policy. If development early on in life begets more development (creating a “snowball effect”) or if there is a sub-set of critical skills which can only be developed during a specific period of development, this makes investments earlier on in life far more valuable than is currently acknowledged (Heckman, 2000). Early-life shocks, generally defined as taking place before the age of five, may represent a “window of vulnerability” in which even relatively small shocks may have significant impacts.

Shocks that take place while individuals are in the womb, during the nine months of gestation, is a potential example of one such “window of vulnerability”. Epidemiologists have argued that even relatively minor changes in the womb due to differences in nutrition can have large impacts on adult outcomes. Referred to as the “fetal origins” hypothesis, the intra-uterine environment may serve a role in programming a range of triggers for later in life, which would make insulating pregnant mothers from shocks critically important for the future outcomes of the child. Programming is a well-established biological phenomenon, and there is strong evidence that nutrition is a central programming stimulus (Harding, 2001).

Ramadan is the ninth month of the Islamic calendar, and is observed as a month of fasting by Muslims all over the world. While fasting from dawn to sunset, Muslims avoid consumption of food or liquids, smoking, sex, and in some interpretations swearing. Although pregnant mothers are technically exempt from the observance, there is strong evidence to suggest that a large proportion

of pregnant women observe the fast, creating an early-life shock that impacts on a huge number of individuals around the world (Almond and Mazumder, 2011). In so far as mothers do not observe the fast, these results underestimate the impact of fasting during gestation on individuals.

This paper uses data from the Indonesian Family Life Survey (IFLS) to estimate the impact of Ramadan fasting during gestation on outcomes later on in life. Individuals who are exposed to Ramadan fasting during the first trimester of gestation are estimated to earn 11.4% less, and have 3.8% less years of education. There is also strong evidence to suggest that the impact of shocks differ by gender.

A range of different mechanisms for these impacts are investigated: differences in physical and mental health, selective conception, changes in the gender ratio, differences in preferences. No evidence is found to suggest that any of these mechanisms are responsible for the core results.

Ramadan has a number of unique features among fetal shocks that make it particularly worthy of investigation. Previous studies on intra-uterine shocks often exploit uncommon or severe shocks which, although interesting in their own right, do not provide evidence on whether milder shocks have significant long-lasting effects. Ramadan fasting is a relatively mild-shock to the child in gestation, with the caloric intake of the mother not changing radically due to the Ramadan fast. However, the change in the pattern of food consumption causes changes in the intra-uterine environment may have lasting effects; shocks to maternal and fetal nutrition from the epidemiological literature show that even mild shocks to maternal nutrition can have impacts on adult outcomes. Fetal development (including cognitive function) can be affected by nutritional variation that would be within the normal range of western diets, and that this

difference in development can be entirely independent of birth weight or size (Gluckman and Hanson 2004).

Due to the widespread observance of Ramadan, even small effects due to these shocks imply large welfare losses in the aggregate. Ramadan is observed by over 90% of the Muslim world, with almost all pregnant women reporting observing the fast (Almond and Mazumder, 2011), implying that roughly 75% of individuals have some exposure to Ramadan during gestation. Conservative estimates still imply that nearly a billion Muslims have been exposed to Ramadan during gestation, absent selective conception. Indonesia is an ideal setting to investigate this shock, having the largest Muslim population in the world. Almost 13% of the worlds Muslims live in Indonesia, with 86.1% of Indonesians identifying as Muslim.

The paper is organised as follows. Chapter 2 provides an overview of the literature and Chapter 3 gives details on the data-set used to do the analysis. Chapter 4 outlines the estimation strategy, and Chapter 5 presents the core results. Chapter 6 presents regressions investigating possible channels of effect, and Chapter 7 provides a brief concluding summary.

## CHAPTER 2

### LITERATURE REVIEW

The idea that events early on in an individual's life could have large, persistent effects did not originate in economics. Epidemiologists have long been concerned with early-life shocks, with Kermack (1934) noting in *The Lancet* that “each generation after the age of 5 years seems to carry along with it the same relative mortality throughout adult life”. Evidence from this literature shows that early-life shocks influence the onset of chronic diseases such as osteoporosis, poly-cystic ovarian syndrome, mood disorders and psychoses (Gluckman and Hanson, 2004). Given the oft-intertwined nature of health, educational and labor market outcomes, this research is suggestive of impacts on individuals that are not restricted to differences in health.

Of particular interest is the roughly nine month period of time that individuals spend *in utero*. Often referred to as the “fetal origins” hypothesis, it is argued that the intrauterine environment “programs” the fetus for different adulthood outcomes (Barker, 1990). There is a large amount of evidence across both economics and epidemiology that suggests that this period may be especially critical for later-life outcomes.<sup>1</sup> This includes, but is not limited to, studies of the 1918 influenza pandemic, the 1846 Dutch famine, differences in air pollution, prenatal exposure to cigarettes and alcohol, even exposure to radiation from Chernobyl. The results of these studies largely confirm that the prenatal shocks have a particularly large impact on outcomes in adulthood, with Currie and Almond (2011) noting, “the evidence above suggests that the period while children are *in utero* is one of the most important to their later development”.

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<sup>1</sup>Almond and Currie (2011) outline this argument in detail before reviewing the empirical literature.

The roots of the economics literature on the influence of early-life shocks begin in debates over the determinants of earnings. A wealth of literature by labor economists use longitudinal studies to show that much of the variation in income, employment and attainment of human capital can be explained using data that we have from very early on in an individuals life. In particular, much of this literature emphasised that much of this variation could not be directly attributed to differences in cognitive skills between individuals<sup>2</sup>.

Keane and Wolpin (1997) use data from the National Longitudinal Surveys of Youth to estimate that 90% of the variance in lifetime utility can be accounted for by unobserved endowment heterogeneity as measured at age 16, but only 10% of that can be accounted for using standard measures of family background. This result suggests that investments before the age of 16 play a critical role. Currie and Thomas (1999) focus on an even earlier range of ages, using data from the British National Child Development Survey to show that test scores measured at as early as seven years old can predict wages. Children who place in the lowest quartile of a reading test have wages 20% lower as adults than those in the the highest quartile, when wages are measured at the age of 33. These studies clearly suggest that small differences in childhood can lead to large differences in outcomes later in life.

Seminal work by Heckman (2000) and Heckman and Rubenstein (2001) gave prominence to the idea that the importance of non-cognitive skills in labor market success implied a clear channel through which this could take place. If non-cognitive skills are more malleable at a younger age, and these non-cognitive skills aid the development of both cognitive and non-cognitive skills over time,

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<sup>2</sup>Bowles, Gintis and Osborne (2001) provide an overview of this literature. Bowles and Gintis's 1973 book *Schooling in America* is oft-referenced in this literature, as it hinted at these ideas well before the work by other economists in the early '00s.

this would imply that early-childhood is a critical period in which shocks are likely to have a large impact. Currie and Hyson (1999) were one of the first to investigate whether early shocks to an individual's health were confined to impacts on their future health, or whether they would impact a range of human capital measures, pointing the way to fertile ground for a range of empirical studies.

This literature has inspired a flurry of research in the last decade which utilise exogenous shocks to individual's before the age of five to estimate their impact on later-life outcomes.<sup>3</sup> Empirical studies have confirmed that a range of shocks early on in life have large long-term impacts.

Maccini and Yang (2009) use an earlier wave of the Indonesian Family Life Survey to estimate impacts of changes in rainfall in each individual's birth year on adult outcomes. They find that higher early-life rainfall has large positive effects on outcomes for women, but not for men. Women with higher rainfall relative to the norm in their birth year complete more years of education, are (marginally) taller, and live in wealthier households as adults. One plausible interpretation of this gender differentiated impact is that there are significant differences by gender in how children are insulated from shocks. If baby boys are prioritised and thus insulated when rainfall is poor, the shock to incomes may not impact them at all.<sup>4</sup>

Ewijk, Reyn and Painter (2013) present evidence using the third wave of the Indonesian Family Life Survey to show impacts on adult Muslims due to

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<sup>3</sup>Currie and Almond (2011) provide a recent and comprehensive survey of the literature

<sup>4</sup>Parental response to early-childhood shocks is in itself a burgeoning field of study. Almond and Mazumder (2013) provide a review of this literature. Although it is intuitive as economists that parental responses would be widespread, and thus present a key problem in estimating the true magnitude of the effects of shocks, there is little evidence to suggest that compensatory investments are common.

prenatal exposure to Ramadan, and find that those exposed to Ramadan in utero are slightly thinner (-0.32 less on the adjusted adult body mass index (BMI) on average) and shorter (-0.8 cm on average) than those that were not exposed. Although this study indicates that exposure to Ramadan has had some impact on individuals, the magnitudes of these impacts are extremely small. It is unclear what the consequences of these differences are likely to be, in terms of welfare for the individual.

Almond and Mazumder (2011) present the evidence most directly relevant to this study. The authors use data from the Arab population in Michigan, Muslims in Uganda and Muslims in Iraq in order to estimate the effect of Ramadan observance during pregnancy. Utilising natality data in Michigan, many of identifying assumptions can be tested and precise dates on gestation can be established. They find that prenatal exposure to Ramadan results in lower birthweight, and that exposure in the first month reduces the number of male births. They also find that Muslims in Uganda and Iraq are roughly 20% more likely to be disabled as adults if exposed to Ramadan, with most of these impacts coming from exposure during the first month of gestation.

Overall, the literature overwhelmingly supports the idea that shocks that occur early on in life can have large, persistent effects on adult outcomes. Studies from economists and epidemiologists consistently show that shocks that occur during gestation, particularly during the early months of gestation, have a large and persistent effect on a range of health and human capital outcomes. There is a strong empirical and physiological basis to believe that even mild shocks, such as the change in nutrition due to the observance of Ramadan, can generate economically significant impacts later in life.

## CHAPTER 3

### DATA

#### 3.1 Indonesian Family Life Survey

The Indonesian Family Life Survey (henceforth, the IFLS) is an ongoing panel dataset collecting information from 13,792 men and 14,926 women at the individual, family and community level. The survey is comprehensive, making it ideal for studying the effect of a shock that could potentially have impacts on a wide range of outcomes.

The IFLS includes, but is not limited to, measures of economic prosperity and wealth (consumption, income, assets), investments in human capital and labor market outcomes (education, industry, length of employment), indicators of health (height, weight, lung capacity, disabilities, mental illness) as well as questions aimed at revealing “deep preferences” which are harder to observe, such as trust attitudes, risk-aversion and inter-temporal preferences.

The IFLS was collected in 13 of the 27 provinces of Indonesia,<sup>1</sup> and is a representative sample for approximately 83% of the Indonesian population. The first wave of the IFLS was collected in 1993/1994 and the latest wave, IFLS4, was collected in 2007/2008. Re-contact rates were high, with 90.3% of individuals interviewed in IFLS1 either participating in all four waves or passing away.<sup>2</sup> IFLS4 utilises information from previous waves where possible, making it a particularly detailed source of information as well as aiding its accuracy. IFLS4 is the sole source of data used for this study.

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<sup>1</sup>See Figure 3.1.

<sup>2</sup>87.6% were interviewed in all four waves.





Figure 3.1 – IFLS Provinces

### 3.2 Variables of Interest

The key dependent variables are described in detail below. Three major categories of dependent variables are looked at: health/biological data, measures of education and economic indicators. The sample predominantly consists of adults, with 97.6% of the sample being 16 or older, and the average age being 36 years old.

The health measurements (height, weight and lung capacity) were measured by a trained health worker. There appears to be some measurement error in the health measurements, with implausible weights and heights recorded for some individuals, so any measurements outside three standard deviations of the average measurement have been excluded from the analysis.<sup>3</sup>

<sup>3</sup>The minimum weight cutoff was 20.73kg and the minimum height cutoff was 119.9cm. Maximum values were not imposed as they would only eliminate one or two observations that are much more plausible than the values at the lower-end of the distribution. It seems clear that this is due to measurement error, as the error occurs in either height or weight but not both. The resulting implied BMI values would make the individual impossibly obese, or have them weighing less than a skeleton of equivalent height. Although there are still some extreme BMI values in the data-set, given the extremely conservative approach towards identifying outliers, all of the results reported are identical regardless of how (or if at all) the outliers are discarded.

The number of days absent from work, and the disability indicator are self-reported and are drawn from the survey. The disability indicator is constructed by setting the variable to one if the individual reports being diagnosed with a physical disability, mental disability or brain damage.<sup>4</sup> The self-reported health is a survey measure that ranges from 1 being Very Healthy to 4 being Unhealthy.

The years of education variable is simply the number of completed years of education that each individual, regardless of the type of institution, with the first year of schooling being the first year of primary education. The cognitive test score is the result achieved by each individual of a word memorisation task that was included as part of the survey, in which the individual was read a list of 10 words and asked to recall as many of the words as possible. They were asked to recall the list twice, once immediately after hearing the list of words, and again after they had answered a different section of the survey. The measure reported here simply gives the number of words recalled in total.

The working indicator is set to one as long as the individual has employment. Earnings per month is self-reported, as are hours worked per month and the combined value of the assets that each individual owns.<sup>5</sup>

Relevant summary statistics are given in Table 3.1, and replicated separated by gender in Table 3.2 and Table 3.3. Summary statistics are presented split by gender as Maccini and Yang (2009) find significant differences by gender whilst investigating the effects of an early-childhood shock using IFLS3. Although they utilise a different exogenous shock, the differences may be the result of differing levels of investment by gender rather than differences in the impact of the shock itself.

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<sup>4</sup>Other disabilities are also reported, and will be discussed further later in the paper.

<sup>5</sup>At the time of writing, 1 US dollar buys approximately 12,000 Rupiah.

Table 3.1 – Summary Statistics for Entire Sample

<b>Variable</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min.</b>	<b>Max.</b>	<b>N</b>
Age (years)	36.37	15.29	14	100	28718
Height (cm)	156.04	8.37	120	193.2	27237
Weight (kg)	54.54	11.11	21	149.8	27388
Lung Capacity	322.38	106.68	0	800	27310
Days Absent from Work (last 4 weeks)	1.56	3.82	0	28	27878
Disability (Indicator)	0.037	0.189	0	1	28718
Self-reported Health	2.034	0.503	1	4	27887
Years of Education Completed	7.939	4.579	0	21	28718
Cognitive Test Score	8.911	3.7	0	20	27167
Working (Indicator)	0.691	0.462	0	1	27902
Earnings per Month ('000s of RP)	863.437	1067.820	0	20000	9968
Hours Worked per Month	285.022	197.964	0	541.833	28718
Combined Value of Assets ('000s of RP)	1580983.085	6185330.535	0	228039999	28718

Table 3.2 – Summary Statistics for Men

<b>Variable</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min.</b>	<b>Max.</b>	<b>N</b>
Age (years)	36.36	15.14	15	100	13792
Height (cm)	161.98	6.55	120	192.6	12949
Weight (kg)	56.94	10.85	21	144.3	13045
Lung Capacity	390.74	99.93	60	800	13020
Days Absent from Work (last 4 weeks)	1.333	3.664	0	28	13339
Disability (Indicator)	0.044	0.205	0	1	13792
Self-reported Health	2.007	0.493	1	4	13341
Years of Education Completed	8.331	4.431	0	21	13792
Cognitive Test Score	9.083	3.586	0	20	13083
Working (Indicator)	0.836	0.37	0	1	13352
Earnings per Month ('000s of RP)	955.728	1127.625	0	20000	6392
Hours Worked per Month	240.118	171.012	0	541.833	13792
Combined Value of Assets ('000s of RP)	8786574.85	5104520.271	0	1370599997	13792

Table 3.3 – Summary Statistics for Women

Variable	Mean	Std. Dev.	Min.	Max.	N
Age (years)	36.38	15.42	14	97	14926
Height (cm)	150.65	5.81	120	193.2	14288
Weight (kg)	52.36	10.90	21.1	149.8	14343
Lung Capacity	260.10	67.20	0	650	14290
Days Absent from Work (last 4 weeks)	1.783	3.946	0	28	14539
Disability (Indicator)	0.031	0.174	0	1	14926
Self-reported Health	2.058	0.51	1	4	14546
Years of Education Completed	7.577	4.683	0	20	14926
Cognitive Test Score	8.75	3.795	0	20	14084
Working (Indicator)	0.558	0.497	0	1	14550
Earnings per Month ('000s of RP)	698.470	929.184	0	15000	3576
Hours Worked per Month	326.513	211.652	0	541.833	14926
Combined Value of Assets ('000s of RP)	2229949.632	6975596.087	0	228039999	14926

### 3.3 Ramadan Measures

Three different measures of prenatal Ramadan exposure are used in the previous literature: a measure for whether Ramadan occurred during each of the nine blocks of 30 days proceeding birth, a measure for whether Ramadan occurred during the first, second or third trimester, and a simple indicator for whether Ramadan overlapped at all with the individuals gestation.

Unfortunately no natality data is available as part of the IFLS data-set, so the timing and duration of each individuals gestation must be estimated from the date of birth. Following Ewijk, Reyn and Painter (2013), all individuals gestation is estimated as beginning exactly 267 days before their birth. This means that each trimester is estimated as being exactly 89 days in length. All measures are set to zero if the individual does not identify as being Muslim. Using each individuals birth date in conjunction with the start and end dates of Ramadan each year, it can be estimated where (if at all) Ramadan falls in the gestation of each individual.

The three different Ramadan measures in this paper are constructed. There are three different measures, a measure for exposure during each trimester of gestation, a measure for exposure during each month of gestation and a dummy variable for any exposure at all. However, the definition of the Ramadan variables differs significantly in defining the measures for exposure during each month and trimester as the proportion of the full 30 days of Ramadan<sup>6</sup> that fell within the corresponding period of time, in order to make the measure continuous. The only exception to this is the indicator for Ramadan, which is not continuous, and set to one if even a single day of Ramadan overlaps with the individuals gestation.

This differs significantly from the methodology of Almond and Mazumder (2011) and Ewijk, Reyn, Painter (2013), where the equivalent Ramadan measures were constructed as an indicator for whether there was any exposure at all during the corresponding unit of time, with any overlap being dealt with by allocating the exposure to the earlier time period, regardless of the length of overlap. Making the measures continuous gives more power to the analysis, and more clearly aligns with intuitions of how exposure to Ramadan may affect individuals in gestation.

As Table 3.4 shows, Indonesia is a predominantly Muslim country, with 87.6% of the individuals in the sample self-identifying as Muslim, and as such, the vast majority (72.4%) of the population has some degree of prenatal exposure to Ramadan. There are no obvious differences in prenatal exposure by gender, nor do they differ systematically in their likelihood to be Muslim.

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<sup>6</sup>Ramadan is only 29 days long in leap years, meaning that any individual born on a leap year will have a maximum value of  $\frac{29}{30}$  for any given measure of exposure.

Table 3.4 – Summary Statistics for Ramadan Variable

Variable	Mean	Std. Dev.	Min.	Max.	N
<b>All</b>					
Trimester 1	0.224	0.385	0	1	28718
Trimester 2	0.213	0.378	0	1	28718
Trimester 3	0.214	0.379	0	1	28718
Ramadan during Gestation (Indicator)	0.724	0.447	0	1	28718
Muslim (Indicator)	0.876	0.33	0	1	28718
<b>Men</b>					
Trimester 1	0.222	0.384	0	1	13792
Trimester 2	0.21	0.376	0	1	13792
Trimester 3	0.212	0.379	0	1	13792
Ramadan during Gestation (Indicator)	0.715	0.452	0	1	13792
Muslim (Indicator)	0.87	0.337	0	1	13792
<b>Women</b>					
Trimester 1	0.226	0.385	0	1	14926
Trimester 2	0.216	0.38	0	1	14926
Trimester 3	0.216	0.38	0	1	14926
Ramadan during Gestation (Indicator)	0.732	0.443	0	1	14926
Muslim (Indicator)	0.881	0.324	0	1	14926

## CHAPTER 4

### METHODOLOGY

#### 4.1 Econometric Model

Equation 4.1 is used to estimate the reduced-form linear relationship between adult outcome  $Y_{itg}$ , of adult  $i$  born in month  $m$  of year  $t$ , in district  $g$ , and the various coefficients estimated.

$$Y_{itg} = \sum_{k=1}^3 \beta_{it}^k \cdot \text{Tri}_{it}^k + \theta \cdot X_{it} + \delta_t + \omega_g + \epsilon_{itg} \quad (4.1)$$

The coefficients of interest are  $\beta^1, \beta^2, \beta^3$ , which denote the impact of a full month of Ramadan on the adult outcome when falling on the first, second and third trimester of gestation respectively. A minimal set of exogenous demographic variables are controlled for:  $\theta$  includes a dummy variable for the individual's gender and a set of dummies for each month of birth,  $\delta_t$  is a set of dummies for each year of birth  $t$  and  $\omega_g$  is a set of dummies for the province that the individual was born in.

As Ramadan moves by roughly 11 days per year<sup>1</sup> relative to the Gregorian calendar, it is possible to disambiguate seasonal effects from those caused by Ramadan with sufficient consecutive observations of exposure to Ramadan in the sample. This data-set contains 83 birth cohorts, which means that Ramadan will overlap with each Gregorian calendar month a minimum of twice, when considering all the birth-years contained within the sample. This allows the

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<sup>1</sup>11 days forward relative to the Gregorian calendar each year, with the exception of leap years where it moves 10 days forward.

effects of Ramadan to be identified separately from any seasonal effects through controlling for the month of birth.

The analysis has been restricted to those measures that have been relevant in the previous research, some of which utilised the IFLS data-set but a different shock and some of which assessed the impact of an identical shock, but in other contexts.<sup>2</sup> The core results were found to be robust to differences in specification. Some results from previous studies can be replicated using other specifications (in particular if location of birth is not controlled for), but disappear entirely when more controls are included.

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<sup>2</sup>Given the wealth of information available in the IFLS and a reduced-form estimation approach, a comprehensive analysis of all the possible variables of interest lead to fears that most, if not all, the results are simply the result of false positives. Although these fears cannot be directly addressed formally, by restricting the analysis to previous variables of interest, and eschewing the reporting of the more esoteric variables, it is hoped that they can be minimised.



## CHAPTER 5

### RESULTS

The core results are robust to which of the three Ramadan variables are used. The simplest possible measure, the indicator for any Ramadan exposure, is reported first, then the results will be investigated in more detail using a richer measure for exposure to Ramadan during gestation, the measure that assigns exposure by trimester of gestation. The third measure, exposure for each month of gestation, gives qualitatively similar results to the other two measures of Ramadan exposure, but is much more unwieldy in both presentation and interpretation and will be left to the appendix.<sup>1</sup> All regressions use the estimation strategy outlined in Section 4.1, and described by Equation 4.1. The estimations only differ by the variable of Ramadan exposure used as the variable of interest. For the reader's convenience, only the coefficients of interest are reported for each regression.

#### 5.1 Ramadan Indicator

The basic results using the simplest measure of Ramadan exposure can be seen in Table 5.1. Earnings per Month are 80.03 thousand Rupiah lower on average if the individuals gestation overlapped with Ramadan at all, with the effect being more pronounced for women despite earning less on average. This translates to a 9.3% decrease in earnings, 13.3% for women and 7.3% for men. This estimate is significant at the 1% level for the whole sample, and at the 5% level for the estimate for women, 10% level for men.

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<sup>1</sup>It seems plausible that the lack of natality data makes the Ramadan variable at the level of month of gestation too noisy to provide any additional insight over looking at the exposure in each trimester of gestation.

Individuals exposed to Ramadan also have 0.367 years or 4.6% less education than those that are not exposed to Ramadan during their gestation. There are no significant differences by gender, with this effect being roughly 4.6% for both groups. This estimate is significant at the 1% level for the entire sample, as well as the estimates separated by gender.

In comparison, the differences in biological measurements are much smaller in magnitude and differ much more by gender. Individuals exposed to Ramadan are both smaller and weigh less than those not exposed, and these differences are statistically significant at the 1% level for height, and the 5% level for weight. However, the difference in height is estimated to be approximately 2.4 mm, an almost imperceptible difference. The difference in weight is approximately 350 grams, a moderate difference between the groups but again relatively meaningless. However, these differences in height and weight imply that Ramadan has had some impact on the individual's biological development.

However, the differences in height and weight are only statistically significant for men. Men are 8.5mm shorter if exposed to Ramadan, and weigh 684 grams less, and these results are significant at the 1% level of significance. This is in contrast to the results on earnings and education, where the effects of exposure to Ramadan during gestation on women were equal to or larger than the effect on men. For women, the differences are estimated to be close to zero.

As there is no clear justification for this differing response to the shock due to biological differences between the genders, it suggests that investment compensating for the effects of the shock may differ systematically by gender. Women are better insulated against impacts to the more basic measures of physical health and development but are still impacted heavily when it comes to economic out-

Table 5.1 – Regressions using the Ramadan Indicator

	All	Women	Men
Earnings per Month ('000s of RP)	-80.03 (29.66)***	-92.68 (47.02)**	-69.33 (38.71)*
Mean	863.43	698.47	955.72
$R^2$	0.17	0.21	0.17
$N$	9,956	3,573	6,383
Years of Education	-0.367 (0.058)***	-0.347 (0.082)***	-0.408 (0.081)***
Mean	7.939	7.577	8.331
$R^2$	0.39	0.46	0.33
$N$	27,881	14,543	13,338
Height (cm)	-0.243 (0.091)***	-0.085 (0.123)	-0.393 (0.141)***
Mean	156.044	150.657	161.988
$R^2$	0.53	0.15	0.16
$N$	27,103	14,229	12,874
Weight (kg)	-0.378 (0.163)**	-0.128 (0.228)	-0.684 (0.237)***
Mean	54.545	52.360	56.948
$R^2$	0.19	0.16	0.18
$N$	27,251	14,282	12,969

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

comes. Furthermore, the impact on men on these outcomes is relatively minor in comparison to the effect on earnings. This suggests that the causal chain of the shock is not likely to be purely related to standard physical health problems.

## 5.2 Exposure by Trimester

The dominant pattern in the regressions using exposure to Ramadan during each trimester of gestation is that of the magnitude of the shock being larger the earlier

that the shock occurs during gestation. Both the combined and gender separated regressions generally show this pattern across the results, with the exception of the regression on weight and height for women, where the impact of Ramadan exposure is statistically insignificant for all three trimesters of gestation.

The impact of exposure to a full month of Ramadan, entirely during the first trimester of gestation can be seen in Table 5.2. The shock lowers earnings per month by 98.67 thousand rupiah, or 11.4%, when considering the entire sample, and is significant at the 1% level. When estimating the effect of exposure during the first trimester looking only at women, the effect is estimated to be 120.22 thousand rupiah, or 17.2% of their earnings, a dramatic increase in magnitude. Men earn 84.36 thousand rupiah less, which translates to 8.8% of their earnings. Both these estimates are significant at the 5% level.

When considering the entire sample, estimates of the effect of exposure during the second and third trimester remain significant and negative, and only marginally decreasing in magnitude. For the gender separated regressions, the estimates remain negative but are either not significant or only marginally so.

The impact of exposure to Ramadan on the number of years the individual is educated shows similar patterns to the results on earnings, and can be seen in Table 5.3. The impact of the shock is largest when the shock occurs in the first trimester of gestation, and this is true regardless of whether the analysis is on the whole sample or separated by gender. Individuals have 0.307 less years of education, or 3.8% less, when Ramadan overlaps in full with the first trimester of gestation, dropping to 0.24 years or 3.1% for women and increasing to 0.375 years or 4.5% for men. Estimates for all three trimesters of gestations are significant at the 1% level of significance when looking at the entire sample, and stay roughly

consistent in magnitude.

When looking at the results on the number of years of education, separated by gender, the impact is not significant for the second trimester for women, but remains significant for the third trimester. For men, the effects are significant at the 1% level for all three trimesters of gestation, and the estimated effects are also larger in magnitude. However, as men have more education on average in this sample, the effects do not differ much as a percentage.

These results largely echo those of the previous section. Earnings and levels of education decrease due to exposure to Ramadan, and this effect is statistically significant for each gender taken separately as well as when they are considered in the aggregate. Using the richer measure of Ramadan allows us to see that the shock has greatest impact when it takes place in the first trimester of gestation, something that would be expected given previous research and our understanding of prenatal shocks in general. There is some evidence to suggest that these effects may differ by gender, with the decrease in earnings being greater in both absolute and relative size for women. This effect is particularly peculiar given that the impact of the shock on education seems, if anything, slightly stronger on men.

Turning to the results on health and weight, impacts are again generally highest when the shock occurs in the first trimester. These results vary much more strongly by gender, with none of the estimates being significantly different from zero when considering women separately. When considering the sample of men, the results are similar to those when considering the Ramadan indicator, with statistically significant but small effects on the weight and height of men in adulthood.

Table 5.2 – Impact of Ramadan on Earnings per Month

	All	Women	Men
Trimester 1	-98.66 (31.36)***	-120.21 (48.51)**	-84.43 (41.59)**
Trimester 2	-82.51 (31.11)***	-80.88 (47.74)*	-73.83 (41.34)*
Trimester 3	-79.75 (31.64)**	-96.06 (48.81)**	-59.51 (41.88)
Mean	863.43	698.47	955.72
$R^2$	0.17	0.21	0.17
$N$	9,956	3,573	6,383

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors

clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table 5.3 – Impact of Ramadan on Years of Education

	All	Women	Men
Trimester 1	-0.307 (0.067)***	-0.251 (0.092)***	-0.388 (0.097)***
Trimester 2	-0.273 (0.066)***	-0.145 (0.091)	-0.406 (0.096)***
Trimester 3	-0.263 (0.067)***	-0.239 (0.092)***	-0.315 (0.098)***
Mean	7.939	7.577	8.331
$R^2$	0.39	0.46	0.33
$N$	27,881	14,543	13,338

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors

clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

In contrast to the results on weight using the Ramadan indicator, the coefficients of interest in the height regression are not statistically significant when considering the entire sample. Although still directional, looking at the regressions separated by gender, it's clear that this effect on height is occurring predominantly in the men in the sample. Men exposed to the shock are again shorter, with this effect being significant at the 5% level for both the first and second trimester of gestation, but the magnitude of the effect is estimated as being 3.8mm, an almost imperceptible effect.

Although the estimates of the shock on individuals weight over the entire sample are still significant in all three trimesters of gestation, the shock does not significantly differ from zero when considering the sample of women. When considering men separately, we see that the shock has a significantly larger impact when it is during the first trimester of gestation, with men exposed in the first trimester being almost a full kilogram lighter on average if they have been exposed.

Table 5.4 – Impact of Ramadan on Height (cm)

	All	Women	Men
Trimester 1	-0.148 (0.112)	0.066 (0.147)	-0.392 (0.171)**
Trimester 2	-0.180 (0.110)	0.040 (0.145)	-0.368 (0.168)**
Trimester 3	-0.136 (0.112)	-0.151 (0.148)	-0.104 (0.172)
Mean	156.044	150.657	161.988
$R^2$	0.53	0.15	0.16
$N$	27,103	14,229	12,874

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table 5.5 – Impact of Ramadan on Weight (kg)

	All	Women	Men
Trimester 1	-0.497 (0.193)**	-0.069 (0.272)	-0.988 (0.278)***
Trimester 2	-0.446 (0.190)**	-0.350 (0.268)	-0.525 (0.274)*
Trimester 3	-0.432 (0.194)**	-0.440 (0.272)	-0.491 (0.278)*
Mean	54.545	52.360	56.948
$R^2$	0.19	0.16	0.18
$N$	27,251	14,282	12,969

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

The results using exposure by trimester of gestation are largely consistent with those using an indicator as the measure of Ramadan exposure in utero. Individuals exposed to Ramadan during gestation earn less, have less education, weigh less and are shorter. However, the effects on their height and weight are statistically significant but negligible, and furthermore do not have a statistically significant effect when we run the regression on only the women in the sample.

Using this richer measure of exposure to Ramadan shows us that the shock has a larger effect when it occurs earlier in gestation. Impacts on earnings are largest if the shock occurs in the first trimester across all three regressions, and in two of the three education regressions with the estimate being only marginally larger in the third regression, looking at only the men in the sample. With the weight and height regressions, we see this pattern again in all regressions in which at least one of the estimates of interest is significantly different from zero. Not only are these results interesting independently, they are also consistent with the previous literature on pre-natal shocks and the medical literature on windows

of vulnerability during gestation<sup>2</sup>.

### 5.3 Impact of Ramadan on Non-Muslims

A natural test of robustness for these results is to look at the results of an identical analysis using only the data from the non-muslim population. Being a predominantly Muslim nation, it is possible that there may still be some impact on non-muslims if their gestation overlaps with Ramadan, but minimally it would be expected that the impacts would be much smaller than the impact on their Muslim counterparts.

Table 5.6 shows the analogue of Table 5.1, with identical regressions being run but only for those who do not identify as being Muslim. None of the estimates are significant, although the number of years of education is marginally significant when only considering men. The estimates often differ in direction to Table 5.1 and are largely incoherent.

Looking at Tables 5.7 and 5.8, estimates are again largely incoherent and not significant, with the only exception again being the number of years of education for men, with the coefficient for shocks in the second trimester being significant at the 5% level and marginally significant at the 10% level when considering the whole sample. In Tables 5.9 and 5.10, none of the coefficients are statistically significant, with the coefficient for the impact of Ramadan on height being marginally significant for the first trimester.

Out of 48 coefficient estimates, we would expect to see two estimates to be

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<sup>2</sup>As mentioned previously, these results are almost identical when the measure of Ramadan is the one in which exposure is divided by the month of gestation.



Table 5.6 – Regressions using the Ramadan Indicator for Non-Muslims

	All	Women	Men
Earnings per Month ('000s of RP)	65.54 (99.92)	169.11 (140.47)	-55.84 (154.57)
Mean	1,066.899	895.161	1,171.653
$R^2$	0.59	0.59	0.69
$N$	937	355	582
Years of Education	-0.284 (0.188)	-0.253 (0.284)	-0.499 (0.238)**
Mean	7.446	7.142	7.745
$R^2$	0.44	0.54	0.41
$N$	2,760	1,401	1,359
Height (cm)	0.026 (0.333)	-0.041 (0.466)	-0.227 (0.518)
Mean	157.414	151.752	163.301
$R^2$	0.58	0.29	0.26
$N$	2,610	1,338	1,272
Weight (kg)	-0.078 (0.571)	0.058 (0.888)	-0.668 (0.798)
Mean	56.678	53.365	60.105
$R^2$	0.32	0.28	0.34
$N$	2,627	1,342	1,285

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

significant at the 5% level and approximately five estimates to be marginally significant, purely due to chance.<sup>3</sup> In this case, we have one estimate marginally significant, and one estimate significant at the 5% level of significance.

Overall, there is no evidence to suggest that exposure to Ramadan during gestation has a similar impact among non-muslims, with many of the point estimates being strongly in the opposite direction to what would be expected.

<sup>3</sup>As these estimates are not independent, with significance in either of the gender regressions making it more likely that the combined regression will be statistically significant, this is a conservative estimate of how many estimates are likely to be statistically significant purely by chance.

Table 5.7 – Earnings per Month Regression for Non-Muslims

	All	Women	Men
Trimester 1	-105.50 (113.24)	-180.90 (175.54)	-173.34 (169.04)
Trimester 2	73.32 (125.59)	237.19 (192.73)	-78.17 (210.03)
Trimester 3	88.39 (112.63)	123.23 (160.79)	41.16 (155.23)
Mean	1,066.89	895.16	1,171.65
$R^2$	0.59	0.59	0.69
$N$	937	355	582

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table 5.8 – Years of Education Regression for Non-Muslims

	All	Women	Men
Trimester 1	-0.266 (0.228)	-0.315 (0.327)	-0.328 (0.295)
Trimester 2	-0.353 (0.226)	-0.149 (0.341)	-0.643 (0.307)**
Trimester 3	-0.251 (0.258)	-0.527 (0.352)	-0.257 (0.342)
Mean	7.446	7.142	7.745
$R^2$	0.44	0.54	0.41
$N$	2,760	1,401	1,359

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table 5.9 – Height Regression for Non-Muslims

	All	Women	Men
Trimester 1	-0.331 (0.394)	-0.883 (0.527)*	-0.319 (0.615)
Trimester 2	-0.166 (0.374)	-0.107 (0.556)	-0.621 (0.568)
Trimester 3	-0.095 (0.377)	-0.471 (0.507)	-0.027 (0.626)
Mean	157.414	151.752	163.301
$R^2$	0.58	0.29	0.26
$N$	2,610	1,338	1,272

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table 5.10 – Weight Regression for Non-Muslims

	All	Women	Men
Trimester 1	0.704 (0.666)	0.553 (1.000)	0.233 (1.101)
Trimester 2	-0.010 (0.648)	-0.246 (0.966)	-0.396 (0.960)
Trimester 3	-0.651 (0.647)	-0.631 (0.913)	-1.309 (0.934)
Mean	56.678	53.365	60.105
$R^2$	0.32	0.28	0.34
$N$	2,627	1,342	1,285

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

## CHAPTER 6

### DISCUSSION

Although the analysis shows that there are significant impacts of exposure to Ramadan during gestation on adult outcomes, the reduced-form estimation approach does not shed any light on the mechanisms through which these impacts take place. A number of possible explanations will be examined; the impact of the shock on the gender ratio, physical health, mental health, differences in subjective perceptions and deper preferences.

Due to the richness of the IFLS data-set, many of these issues can be examined with analogous analysis to the analysis in Section 5, directly investigating whether exposure to Ramadan during gestation had effect on other variables.

#### **6.1 Selective Timing of Conception**

One possible explanation for the results is systematic differences in the parents who concieve directly before or directly after Ramadan. For instance, if better educated Muslim families avoid conception directly before Ramadan and concentrate their conceptions in the months directly after Ramadan, or if less educated Muslim families are less able to prevent/delay conceptions, this could generate the results in the previous section. In a similar manner, if the health of parents differs systematically with conception before or after Ramadan this could also generate these results.

Table 6.1 presents regressions using Equation 4.1 using characteristics of the parent as the dependent variable. Specifically, the regressions look at whether exposure to Ramadan systematically differs with the parents education or health.

Table 6.1 – Regression on Parental Characteristics

	Mothers Education	Fathers Education	Mothers Health	Fathers Health
Trimester 1	0.009 (0.101)	-0.009 (0.103)	-0.003 (0.014)	0.007 (0.016)
Trimester 2	0.106 (0.102)	0.148 (0.104)	0.005 (0.014)	0.018 (0.015)
Trimester 3	0.087 (0.105)	-0.032 (0.105)	-0.002 (0.015)	0.010 (0.016)
Mean	5.426	6.019	2.327	2.440
$R^2$	0.16	0.16	0.14	0.12
$N$	10,532	13,434	18,516	19,644

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

The education variable here is identical to that used for each individual, giving the number of years of education that each parent has completed. The health measure is a survey question, ranging from 1 being Very Healthy to 4 being Very Unhealthy.

There is no evidence of selective gestation by education directly before or directly after Ramadan. Exposure to Ramadan during gestation was roughly equal across trimesters, and very close to the expected proportion of individuals being exposed to Ramadan during gestation if individuals were uniformly distributed over the Islamic calendar year. The education and health of the parents do not vary systematically with conception relative to Ramadan, with none of the three trimesters having significantly different parental characteristics. The point estimates are all very close to zero, with no estimates being statistically significant at any level of significance.

Table 6.2 – Regression on Sex Indicator

	Sex
Trimester 1	-0.006 (0.010)
Trimester 2	-0.008 (0.009)
Trimester 3	-0.007 (0.010)
$R^2$	0.02
$N$	27,881

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

## 6.2 Impact on Sex Ratio

A concern may be that some of the results may be being driven by changes in the composition of sex in the adult population. In particular, the lack of impact of the shock on female height and weight as seen in Tables 5.4 and 5.5 may potentially be driven by less healthy female children suffering more complications at birth, or differences in rates of mortality before adulthood. In order to investigate this, a regression analogous to those run in the previous analysis using the model described by Equation 4.1, is simply run using the indicator variable for the individuals sex (set to one if they are male, zero if they are female) as the dependent variable, and the results are presented in Table 6.2.

There is no evidence that exposure to Ramadan alters the sex ratio in the adult population, and thus no evidence that changes in the sex ratio plays a role in generating these results. Results are presented in Table 6.2. None of the coefficients for the impact of the shock in each trimester are statistically significant, and all the point estimates are close to zero.

### 6.3 Physical Development and Health

Another potential channel is that of physical health. If those exposed to Ramadan during gestation are more likely to miss work due to illness or to be less healthy in general, this could lead to lower productivity and generally lower output. A detrimental impact on the general health and well-being of those exposed to Ramadan during gestation could help to explain the results above. The IFLS includes a large range of indicators of health, so this channel can be investigated directly. In order to assess the plausibility of this channel, regressions are again run using the econometric model outlined by Equation 4.1. Four dependent variables are considered in this analysis: the number of days the individual has been absent from work in the last month, an evaluation of the individuals health on a nine point scale by a health worker, the individuals self-reported level of health on a four point scale, and their lung capacity as measured by a health worker.

There is no evidence to suggest that exposure to Ramadan during gestation has any adverse effects on an individuals general health. The results are presented in Table 6.3. None of the estimates are statistically significant, with all the point estimates are very precisely estimated to be close to zero.<sup>1</sup>

Another way in which exposure to Ramadan could explain the results would be through increasing the likelihood of disabilities. If exposure to the shock significantly increased the likelihood of disabilities occurring by adulthood, this could help to explain the results above. There is some reason to believe this

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<sup>1</sup>Analysing the impact of the shock on the number of days absent from work using various Tobit regression specifications (not shown) produced results that were qualitatively similar to the OLS estimate, but could not be estimated with an identical specification as the location indicators became too sparse to estimate standard errors on the coefficients.

Table 6.3 – Regression on Health Variables

	Days Absent	Health (Worker)	Health (Self)	Lung Capacity
Trimester 1	0.004 (0.073)	-0.019 (0.015)	-0.003 (0.009)	0.324 (1.435)
Trimester 2	-0.018 (0.072)	-0.006 (0.015)	-0.007 (0.009)	-0.164 (1.410)
Trimester 3	0.041 (0.076)	-0.004 (0.015)	0.004 (0.010)	-0.201 (1.374)
$R^2$	0.05	0.44	0.08	0.55
mester Mean	1.568	5.845	2.034	322.389
$R^2$	0.44	0.05	0.08	0.55
$N$	20,380	27,850	27,859	27,177

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

may be the case, with Almond and Mazumder (2011) showing evidence from the Uganda and Iraqi contexts that Ramadan may significantly increase the likelihood of disabilities. The disability variable here is self-reported, and is the answer to the question “Has a medical practioner ever diagnosed you with...”.

Analogous tables to those on p.75 of the Almond and Mazumder (2011) paper are presented in Table 6.4, using month of exposure as the measure of the Ramadan shock.<sup>2</sup> Each disability measure is an indicator variable, and is self-reported. The first column is simply an aggregate measure, being set to one if any of the other variables are equal to one.

The vast majority of the coefficients do not significantly differ from zero. This is not entirely surprising, as the indicator variables are very sparse - only 10.5% of the population report a disability of any form, with many of the disability variables affecting a very small proportion the population. Problems with vision

<sup>2</sup>These results are robust to the measure of Ramadan used, producing qualitatively similar results when using trimester of exposure or the Ramadan indicator.

make up over half the reported disabilities, with only vision and heart problems having an incidence over 1%.

Three of the coefficients are statistically significant at the 5% level. We see that the complete overlap of the 5<sup>th</sup> month of gestation and Ramadan is associated with 1.6% decrease in the likelihood of having vision problems, a result that is at odds with both the previous literature and what modern medical knowledge would suggest. The other two statistically significant coefficients are for month six and seven on the regression on depression. The shock occurring in the 6<sup>th</sup> month of gestation is estimated to increase the likelihood of depression by 0.2%. However, the impact of the shock in the 7<sup>th</sup> month of gestation is estimated to decrease the likelihood of depression by 0.3%.

Out of 81 coefficient estimates, four coefficients would be expected to be significant at the 5% level and eight coefficients at the 10% purely due to chance. In Table 6.4 there are eight coefficients significant at the 10% level, and three coefficients significant at the 5% level. However, two of the three coefficients that differ significantly from zero are negative, implying that Ramadan during gestation actually prevented disabilities. Given these largely ambiguous and incoherent results, there is little evidence to suggest that physical disabilities caused by exposure to Ramadan fasting during gestation is a channel through which these results are generated.

## **6.4 Mental Development and Health**

If Ramadan exposure had an impact on the speed and/or eventual level of mental development, this could help to explain the differences in wages and level of



Table 6.4 – Regressions on Disability Outcomes

	Any	Physical	Brain Damage	Vision	Hearing
Month 1	0.001 (0.003)	-0.002 (0.003)	-0.001 (0.001)	-0.008 (0.008)	0.000 (0.003)
Month 2	-0.006 (0.004)	-0.003 (0.002)	-0.000 (0.001)	-0.011 (0.007)*	-0.003 (0.002)
Month 3	0.003 (0.004)	-0.001 (0.003)	-0.001 (0.001)	-0.003 (0.007)	0.002 (0.003)
Month 4	-0.008 (0.004)**	-0.002 (0.002)	-0.001 (0.001)	-0.009 (0.007)	-0.002 (0.002)
Month 5	-0.000 (0.003)	-0.000 (0.003)	-0.001 (0.001)	-0.016 (0.007)**	-0.001 (0.002)
Month 6	0.002 (0.003)	0.002 (0.003)	-0.002 (0.001)*	-0.011 (0.007)	-0.002 (0.002)
Month 7	-0.006 (0.004)	-0.002 (0.003)	0.000 (0.001)	-0.009 (0.007)	-0.001 (0.003)
Month 8	-0.000 (0.003)	0.002 (0.003)	-0.002 (0.001)*	0.002 (0.007)	-0.000 (0.003)
Month 9	-0.000 (0.003)	-0.003 (0.003)	-0.001 (0.001)	-0.007 (0.008)	-0.004 (0.002)
Mean	0.105	0.007	0.001	0.055	0.007
$R^2$	0.03	0.02	0.02	0.07	0.03
$N$	27,881	27,857	27,857	27,857	27,857

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

education between those exposed, and those that were not. Measures of mental “ability” or capacity are notoriously difficult define, and once defined even more elusive to credibly capture. The measure used in this paper has similar issues. There is only one measure of cognitive capacity measured, a test of the individual’s memory.

Each individual was read a list of 10 words<sup>3</sup> and asked to memorise as many words as they possible could. After a short pause, they were asked to recall as

<sup>3</sup>Translations of the lists of words used is shown in Figure 6.1.

Table 6.5 – Regressions on Disability Outcomes Continued.

	Speech	Mental	Heart Problems	Depression	Autism
Month 1	0.001 (0.001)	-0.000 (0.000)	0.002 (0.004)	-0.000 (0.001)	0.000 (0.000)
Month 2	-0.000 (0.001)	0.001 (0.001)	-0.004 (0.003)	0.001 (0.002)	-0.000 (0.000)
Month 3	0.000 (0.001)	-0.000 (0.000)	0.001 (0.004)	-0.002 (0.001)**	-0.000 (0.000)
Month 4	-0.000 (0.000)	0.000 (0.001)	0.006 (0.004)	0.002 (0.002)	-0.000 (0.000)
Month 5	0.000 (0.001)	-0.000 (0.000)	-0.004 (0.004)	-0.001 (0.001)	0.000 (0.001)
Month 6	-0.001 (0.001)	-0.000 (0.000)*	0.002 (0.004)	0.002 (0.002)	0.000 (0.000)
Month 7	0.002 (0.001)	0.000 (0.000)	-0.003 (0.003)	-0.003 (0.001)***	-0.000 (0.000)
Month 8	-0.000 (0.001)	0.000 (0.000)	0.007 (0.004)*	-0.000 (0.001)	0.000 (0.000)
Month 9	0.000 (0.001)	-0.000 (0.000)	-0.002 (0.004)	-0.001 (0.001)*	-0.000 (0.000)
Mean	0.001	0.000	0.014	0.001	0.000
$R^2$	0.01	0.01	0.04	0.01	0.01
$N$	27,857	27,857	27,857	27,857	27,857

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

many words as they could, in any order that they wished. After they had finished recalling the list of words, they were asked to complete the next section of the IFLS. The next section is the section on acute morbidity, and consists of 80-90 questions on the individual's current health and persistent conditions. After they had finished answering this section of the IFLS, they were asked to again recall as many of the 10 words that they were asked to memorise before answering the section on acute morbidity. They were not read the list of words again.

The first test can be thought of as a test of short-term memory, while the

Figure 6.1 – Lists of Words for Cognitive Tests

LIST A	LIST B	LIST C	LIST D
A01. HOTEL	B01. SKY	C01. MOUNT	D01. WATER
A02. RIVER	B02. OCEAN	C02. STONE	D02. MOSQUE
A03. TREE	B03. FLAG	C03. BLOOD	D03. DOCTOR
A04. SKIN	B04. RUPIAH	C04. CORNER	D04. CASTLE
A05. GOLD	B05. WIFE	C05. SHOES	D05. FIRE
A06. MARKET	B06. MACHINE	C06. LETTER	D06. GARDEN
A07. PAPER	B07. HOUSE	C07. GIRL	D07. SEA
A08. CHILD	B08. EARTH	C08. HOUSE	D08. VILLAGE
A09. KING	B09. SCHOOL	C09. VALLEY	D09. BABY
A10. BOOK	B10. BUTTER	C10. CAR	D10. TABLE

BUKU III B - 13

IFLS4

second test can be thought of as a test of longer-term retention. Since they were asked to recall the full list both times, each individual was able to score upto 10 on each test. The two measures are highly correlated,<sup>4</sup> and analysing the results separately yielded qualitatively similar results to an analysis on the combined score, so only the analysis of the combined score has been presented.

There is no evidence to suggest that exposure to Ramadan fasting during gestation has an adverse effect on individual’s memories. Again, the same regression model is used as for the analyses, with the dependent variable being the combined score on both tests of memory. Regression results can be seen in Table 6.6. Although all the coefficients are in the expected direction, none of the coefficients are statistically significant at any standard level of significance.

Another way in which the shock could produce the results is through negatively affecting various mental health outcomes. The impacts of mental health on the labor market (and vice versa) are little understood, and there is very little evidence or literature in this area. Frank and McGuire (2000) conceptualise the economics of mental health as being much like the economics of health in other areas, but with many of the problems of health economics exacerbated: greater uncertainty and variation in treatments, self-interest assumption more dubious,

<sup>4</sup>The correlation coefficient between the two test scores for each individual is 0.763.

Table 6.6 – Regression on Memory Test

	All	Women	Men
Trimester 1	-0.035 (0.064)	-0.013 (0.088)	-0.075 (0.086)
Trimester 2	-0.006 (0.061)	0.020 (0.084)	-0.049 (0.085)
Trimester 3	-0.008 (0.063)	-0.002 (0.088)	-0.054 (0.088)
Mean	8.911	8.750	9.083
$R^2$	0.30	0.34	0.27
$N$	27,139	14,073	13,066

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

social costs and externalities likely to be large. If exposure to Ramadan during gestation causes mental illness to be more likely, this could explain the lower incomes and lower levels of educational attainment amongst those affected by the shock.

The mental health measures here are self-reported responses to a survey question, and serve as proxies for any underlying mental health issues. Each individual was asked how many days in the week they felt the emotion or feeling in question, with each emotion being given at the top of each column in Table 6.7. This ranged from 1 - Rarely ( $\leq 1$  day) to 4 - Most of the Time (5–7 days). The first column “Any” is an indicator variable, set to 1 if the individual answered 0 to any of the positive emotions (Hopeful, Happy), or 4 to any of the remaining questions on negative emotions. Regressions are again run using the same specification, with the score from 1-4 being used as the dependent variable.

There is no evidence to suggest that exposure to Ramadan has had any impact on the individual’s mental health. Regression results are presented in Table 6.7.

Table 6.7 – Regression on Measures of Mental Health

	Any	Bothered	Distracted	Depressed	Difficult
Trimester 1	-0.001 (0.009)	-0.029 (0.017)*	-0.027 (0.019)	0.002 (0.018)	-0.044 (0.027)
Trimester 2	-0.000 (0.009)	-0.019 (0.017)	-0.001 (0.019)	-0.021 (0.017)	-0.036 (0.028)
Trimester 3	0.003 (0.010)	0.018 (0.018)	0.001 (0.020)	0.004 (0.018)	-0.061 (0.027)**
Mean	0.609	0.318	0.457	0.342	0.982
$R^2$	0.05	0.04	0.05	0.04	0.07
$N$	27,881	27,855	27,855	27,856	27,856

  

	Hopeful	Fearful	Restless	Happy	Lonely	Unmotivated
Trimester 1	-0.040 (0.025)	-0.029 (0.018)	0.014 (0.026)	-0.019 (0.023)	0.014 (0.012)	
Trimester 2	-0.045 (0.024)*	-0.024 (0.018)	-0.003 (0.025)	0.009 (0.021)	-0.003 (0.012)	
Trimester 3	-0.025 (0.024)	-0.020 (0.018)	-0.012 (0.025)	-0.051 (0.022)**	0.020 (0.013)	
Mean	2.912	0.375	0.739	3.017	0.153	0.194
$R^2$	0.09	0.06	0.04	0.05	0.03	0.04
$N$	27,855	27,856	27,856	27,855	27,856	27,856

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

The vast majority of coefficients are not statistically significant, with three being marginally significant and two being significant at the 5% level of significance. However, all five of these coefficients are not in the expected direction and are scattered across the regressions for four different measures. Again, as we are estimating 30 coefficients, we would expect to see one to two coefficients reach the 5% level of significance and three coefficients reach the 10% level of significance through chance alone. The results here are in line with the significance of the coefficients being generated randomly, and do not show any systematic patterns.

## 6.5 Differences in Perceptions and Preferences.

Finally, this prenatal shock may have some impact on deeper preferences and perceptions. Differing attitudes toward risk or future incomes may lead to individuals earning less, and investing less in human capital. Unlike most data-sets, the IFLS includes survey measures of intertemporal preferences and preferences under uncertainty. Both the risk measure and the time measure are a series of hypothetical scenarios. This means that minimum levels of risk aversion and discount rates can be inferred from these survey measures, and investigated directly.<sup>5</sup> Each individual was asked to do two decision trees for each measure, completing four decision trees in total.

For simplicity, a constant relative risk aversion utility function is used to parameterise risk attitudes, and a linear utility is used for the discount rate. As there are two measurements of each preference, a simple average of the implied value is taken as the measure for both the CRRA and the discount rate.

There is no evidence to suggest that changes in time and risk preferences are the channel through which the differences in income and level of education take place. Regressions are presented in Table 6.8. Although the coefficient estimates are in the expected direction, again none of the estimates are statistically significant.

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<sup>5</sup>Survey measures, especially those eliciting time and risk preferences, are viewed with extreme skepticism by most economists. Ideally, these measures are elicited utilising credible stakes, in order to incentivise the individual to give their true preferences. This skepticism is not unwarranted, with studies such as Ding, Hartog and Sun (2010) suggesting that survey measures are noisy indicators of risk preferences at best.

Table 6.8 – Regressions on CRRA and Discount Rate

	CRRA	Discount Rate
Trimester 1	0.010 (0.032)	-4.947 (4.173)
Trimester 2	0.050 (0.031)	-1.862 (4.167)
Trimester 3	0.004 (0.032)	-2.356 (4.156)
Mean	1.257	215.992
$R^2$	0.13	0.06
$N$	14,756	27,781

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

## CHAPTER 7

### CONCLUSION

The results in this paper clearly point to exposure to Ramadan having strong and persistent effects later in life. Although the impacts on height and weight are small in magnitude, the impacts on income and education are non-trivial. Individuals who are exposed to Ramadan in the first trimester earn 11.4% less on average, and have on average 3.8% less years of education. There is evidence to suggest that impacts of the shock differ systematically by gender, implying that parental responses to the shock may significantly alter or ameliorate the effects of exposure.

These results are robust to the measure of Ramadan, and largely echo the previous literature on prenatal shocks. It is clear that prenatal shocks, especially those that occur early in gestation, can have a significant effect on traditional labor market outcomes such as wages and human capital accumulation. However, despite the wealth of variables collected as part of the IFLS, it is unclear which channels lead to the shock having these impacts<sup>1</sup>.

Without being able to isolate the channels of effect, the obvious implication for policy is to simply to avoid the shock altogether. There is no evidence to suggest that individuals are timing conception to avoid exposure to Ramadan, and research shows that despite pregnant women having the option to exempt themselves from Ramadan observance, many choose to observe Ramadan (Almond and Mazumder, 2011). Given the evidence presented in Ewijk, Reyn and Painter (2013), Almond and Mazumder (2011) and here, it seems that a “better safe than

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<sup>1</sup>As the IFLS relies predominantly on self-reported measures, it may be that the obvious hypotheses for these effects tested above are correct, but the measures are simply too noisy to detect the effect.



sorry" approach may be warranted with regards to Ramadan exposure. More broadly, this study provides additional justification for interventions targeting the nutrition of pregnant mothers. Ramadan observance is not a large shock, and it is likely that much harsher shocks are common, especially in the developing context. These results suggest that policies ensuring food security and maternal health, shielding infants from shocks during this critical period, may be some of the most fruitful investments that the government can make in the future welfare of their citizens.

APPENDIX A  
REGRESSIONS USING EXPOSURE TO RAMADAN BY MONTH OF  
GESTATION

Table A.1 – Regressions on Earnings per Month

	All	Women	Men
Month 1	-116.11 (51.30)**	-152.02 (84.89)*	-111.30 (66.25)*
Month 2	-121.22 (44.87)***	-153.57 (66.61)**	-88.36 (61.97)
Month 3	-68.39 (54.01)	-54.54 (108.26)	-73.75 (66.65)
Month 4	-58.31 (52.10)	-137.39 (79.30)*	-33.11 (69.97)
Month 5	-70.35 (63.48)	14.13 (97.17)	-106.57 (82.35)
Month 6	-133.18 (58.29)**	-165.00 (66.05)**	-85.16 (77.96)
Month 7	-25.81 (53.47)	-9.91 (75.71)	-24.19 (74.91)
Month 8	-100.94 (46.08)**	-141.59 (65.15)**	-87.19 (65.31)
Month 9	-110.08 (48.43)**	-128.15 (73.04)*	-70.55 (67.89)
Mean	863.43	698.47	955.72
$R^2$	0.17	0.22	0.17
$N$	9,956	3,573	6,383

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors

clustered on month\*province

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors

clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table A.2 – Regression on Years of Education

	All	Women	Men
Month 1	-0.409 (0.113)***	-0.241 (0.161)	-0.574 (0.157)***
Month 2	-0.375 (0.112)***	-0.377 (0.161)**	-0.384 (0.154)**
Month 3	-0.163 (0.116)	-0.154 (0.153)	-0.232 (0.166)
Month 4	-0.314 (0.111)***	-0.155 (0.157)	-0.497 (0.160)***
Month 5	-0.172 (0.114)	-0.043 (0.158)	-0.318 (0.160)**
Month 6	-0.422 (0.114)***	-0.301 (0.162)*	-0.498 (0.164)***
Month 7	-0.209 (0.119)*	-0.159 (0.164)	-0.302 (0.167)*
Month 8	-0.246 (0.110)**	-0.148 (0.153)	-0.377 (0.159)**
Month 9	-0.342 (0.118)***	-0.382 (0.161)**	-0.309 (0.169)*
Mean	7.939	7.577	8.331
$R^2$	0.39	0.46	0.33
$N$	27,881	14,543	13,338

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors

clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table A.3 – Regression on Height

	All	Women	Men
Month 1	-0.362 (0.187)*	-0.046 (0.244)	-0.749 (0.296)**
Month 2	-0.129 (0.174)	0.052 (0.225)	-0.249 (0.267)
Month 3	-0.111 (0.186)	0.052 (0.249)	-0.383 (0.282)
Month 4	-0.222 (0.193)	0.133 (0.249)	-0.612 (0.285)**
Month 5	-0.242 (0.192)	0.261 (0.254)	-0.739 (0.295)**
Month 6	-0.264 (0.181)	-0.443 (0.229)*	0.013 (0.281)
Month 7	0.101 (0.195)	0.219 (0.257)	0.028 (0.285)
Month 8	-0.299 (0.193)	-0.208 (0.255)	-0.440 (0.288)
Month 9	-0.266 (0.187)	-0.404 (0.251)	-0.083 (0.290)
Mean	156.044	150.657	161.988
$R^2$	0.53	0.15	0.17
$N$	27,103	14,229	12,874

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Table A.4 – Regression on Weight

	All	Women	Men
Month 1	-0.542 (0.315)*	0.082 (0.437)	-1.388 (0.469)***
Month 2	-0.512 (0.334)	0.113 (0.460)	-1.042 (0.462)**
Month 3	-0.476 (0.313)	-0.380 (0.435)	-0.691 (0.478)
Month 4	-0.098 (0.329)	0.045 (0.472)	-0.393 (0.456)
Month 5	-0.676 (0.318)**	-0.426 (0.446)	-0.861 (0.473)*
Month 6	-0.534 (0.342)	-0.405 (0.498)	-0.603 (0.487)
Month 7	-0.384 (0.342)	-0.631 (0.468)	-0.136 (0.504)
Month 8	-0.785 (0.335)**	-0.546 (0.464)	-1.223 (0.479)**
Month 9	-0.042 (0.328)	-0.007 (0.469)	-0.100 (0.468)
Mean	54.545	52.360	56.948
$R^2$	0.19	0.16	0.18
$N$	27,251	14,282	12,969

IFLS4 (see Appendix B). Ordinary Least Squares, estimated using STATA. Robust Standard Errors clustered on month\*province

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

APPENDIX B  
DATA APPENDIX

IFLS4 was obtained from <http://www.rand.org/labor/FLS/IFLS.html> . Downloading the data requires registration and an academic (.edu) e-mail address. All data was accessed in STATA format. The relevant IFLS4 data files are in a zip file at this address ([http://smapp.rand.org/labor/family/software\\_and\\_data/FLS/IFLS/IFLS4/data/stata/hh07\\_all\\_dta.zip](http://smapp.rand.org/labor/family/software_and_data/FLS/IFLS/IFLS4/data/stata/hh07_all_dta.zip)). All .dta files referred to below are found in this zip file. All STATA code for full replication is available upon request.

- Observations in the original file: 29967
- Deleted because Ramadan variable cannot be calculated due to inaccurately recorded date of birth: 28723 (1244 observations deleted)
- Deleted because observation does not have month of birth recorded: 28718 (5 observations deleted)
- Analysis sample: 28718

**SexDum** Indicator variable for gender. Created from `b3a_cov.dta`. Set to 1 if variable 'sex' = 1, otherwise set to 0.

**dob\_mth** Month of birth. Created from `b3a_cov.dta`. No edits made to `dob_mth`

**dob\_yr** Year of birth. Created from `b3a_cov.dta`. No edits made to `dob_yr`

**Location** Defines Province + Municipality. Created from `b3a_mg1,b3a_mg1_97b3a_mg1_00`. Created by:

1. Define `mg01d` and `mg01c` as equal to the values found in `b3a_mg1`.
2. If value is not found for an individual, look for value in `b3a_mg1_00`.

3. If not found, look for value in b3a\_mg1\_97.

All values are two digit identifiers. To uniquely identify each municipality in each province, Location is defined as Province\*100 + Municipality to create a unique 4 digit identifier.

**Weight** Defines Weight in kg. Created from bus1\_1. Identical to values in us06. Value ignored from data-set if below 20.73kg.

**Height** Defines Height in cm. Created from bus1\_2. Identical to values in us03. Value ignored from data-set if below 119.9cm

**YearsEducation** Defines Years of Education completed. Created from b3a\_d11. dl06 provides a code for current or highest level of education attended, from which a minimum number of years of educated is implied. dl07 gives the number of years attended at that institution (or is set to 7 if they graduated), and is added to the number implied by dl06 to give the final value of the variable.

**earningsmonth** Defines Earnings per Month Created from b3a\_tk2. Earnings per Month are drawn from variables tk25a1 and tk25b1, and if they are not available directly, estimated from tk25a2 and tk25b2, which are the earnings per year, which are simply divided by 12.

**Ramadan Variables - RamDum, Tri1, Tri2, Tri3 and M1, M2, M3, M4, M5, M6, M7, M8, M9**  
Created from b3a\_cov.dta. Using dob\_yr, dob\_mth and dob\_day to compute a birthday.

Three different measures of prenatal Ramadan exposure are created: a measure for whether Ramadan occurred during each of the nine blocks of 30 days preceding birth, a measure for whether Ramadan occurred during

the first, second or third trimester, and a simple indicator for whether Ramadan overlapped at all with the individuals gestation.

Unfortunately no natality data is available as part of the IFLS data-set, so the timing and duration of each individuals gestation must be estimated from the date of birth. Following Ewijk, Reyn and Painter 2013, all individuals gestation is estimated as beginning exactly 267 days before their birth. This means that each trimester is estimated as being exactly 89 days in length. All measures are set to zero if the individual does not identify as being Muslim. Using each individuals birth date in conjunction with the start and end dates of Ramadan each year, it can be estimated where (if at all) Ramadan falls in the gestation of each individual.

This is done by assigning each day from 1900 an index number which simply gives the number of days since January 1st, 1900. Then, using Ramadan data which simply assigns a 1 if the day matched to that index number falls within Ramadan or 0 otherwise, it is possible to simply sum up the number of days that fall within Ramadan, and then divide by 30 to generate any of the continuous Ramadan variables.

The three different Ramadan measures in this paper are constructed. There are three different measures, a measure for exposure during each trimester of gestation, a measure for exposure during each month of gestation and a dummy variable for any exposure at all. However, the definition of the Ramadan variables differs significantly in defining the measures for exposure during each month and trimester as the proportion of the full 30 days of Ramadan<sup>1</sup> that fell within the corresponding period of time, in order to make the measure continuous. The only exception to this is the indicator

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<sup>1</sup>Ramadan is only 29 days long in leap years, meaning that any individual born on a leap year will have a maximum value of  $\frac{29}{30}$  for any given measure of exposure.

for Ramadan, which is not continuous, and set to one if even a single day of Ramadan overlaps with the individual's gestation.

**Parent's Education - MomEducation, DadEducation** Defines Years of Education completed by the Mother and Father of the individual.

Created from b3b\_ba0. Defined and created analogously to YearsEducation, with ba08p and ba08m being analogous to dl06, the level of education achieved, while ba09p and ba09m are analogous to dl07, with the variables with the p suffix corresponding to the father and the variables with the m suffix corresponding to the mother.

**Parent's Health - MomHealth, DadHealth** Measure of Health of Parents

Created from b3b\_ba0. Values of MomHealth are identical to ba14am, and the values of DadHealth are identical to ba14ap. The Measure is from 0-4, so all values over 4 are set to missing.

**DaysAbsent** Created from b3b\_kk1. Identical to kk02a.

**NurseHealth** Created from bus2\_3. Identical to us214.

**Health** Created from b3b\_kk1. Identical to kk01.

**LungCapacity** Created from bus2\_1. Three measurements of Lung Capacity are taken, and the average is used for the analysis. The three measurements are given by us209a, us209b, us209c.

**CogAB** Created from b3b\_co2 and b3b\_co3. Each question is given a variable (co07\_1, co07\_2, ...co07\_10 for b3b\_co2 and co10\_1, co10\_2, ...co10\_10 for b3b\_co3) and is set to 1 if the individual respondent got it correct. The number of correct answers in both tests is summed together to create the value for CogAB.

**Disability Variables - DisabilityA, DisabilityB, ..., DisabilityI** Created from b3b\_cd2. cd01type is coded with the disability, and cd01 is set to 1 if they have been diagnosed with it. From this, dummy variables are generated for each individual.

**Mental Health Variables - A, B, ..., I and MentalDum** Created from b3b\_kp. kptype identified the type of mental illness, kp01 was set to 1 if they had experienced it and 3 if they had not. kp02 gave an indication of severity. Using these variables, a variable was constructed for each type of mental illness, corresponding to the value of kp02 if they had experienced the illness and 0 otherwise.



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