ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية
2018

working paper series

PRE-BIRTH EXPOSURE TO RAMADAN, HEIGHT, AND THE LENGTH OF GESTATION

Seyed M. Karimi

Working Paper No. 1236

PRE-BIRTH EXPOSURE TO RAMADAN, HEIGHT, AND THE LENGTH OF GESTATION

Seyed M. Karimi[1]

Working Paper 1236

October 2018

I am especially grateful to Katie Baird, Meltem Dayioglu, William McGuire, and Salim Rashid for their comments and suggestions. Comments from participants of the ERF 23rd Annual Conference and the 3rd Annual Politics, Philosophy, and Public Affairs Colloquium at the University of Washington Tacoma were very helpful as well. I also appreciate the useful discussions with Hossein A. Abbasi, Jamal I. Haidar, and Cynthia Howson, and Mehdi Majbouri. The views findings and conclusions expressed in this paper, however, are those of the author.

Send correspondence to:
Seyed M. Karimi
University of Washington Tacoma
skarimi2@uw.edu

[1] Interdisciplinary Arts and Sciences, University of Washington Tacoma, 1900 Commerce St., Tacoma, WA 98402, fax 253.692.5718, phone 253.692.4945, skarimi2@uw.edu.

First published in 2018 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Copyright © The Economic Research Forum, 2018

All rights reserved. No part of this publication may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without permission in writing from the publisher.

The findings, interpretations and conclusions expressed in this publication are entirely those of the author(s) and should not be attributed to the Economic Research Forum, members of its Board of Trustees, or its donors.

Abstract

The effect of pre-birth exposure to Ramadan, the Muslim month of fasting, on children's height and an array of pregnancy, delivery, and postpartum outcomes— namely birthweight, neonatal mortality, breastfeeding initiation and duration, and a series of maternal pregnancy and delivery complications— was measured. Since the birth and postpartum outcomes correlate with the length of gestation, they can provide evidence on the effect of exposure to Ramadan on the length of gestation. I used data from 98 demographic and health surveys from 37 low and lower-middle income countries and found that pre-birth exposure to Ramadan decreases a Muslim male child's height by as much as 12.2 mm on average. The examinations of the other outcomes did not provide strong evidence on the impact of exposure to Ramadan on gestation length.

***JEL Classifications*:** I15, J13, O15, I12

Keywords: Ramadan, Height, Birthweight, Neonatal Mortality, Breastfeeding, Pregnancy and Birth Complications.

ملخص

تقدم هذه النبذة قياسا لأثر التعرض قبل الولادة لشهر رمضان، شهر الصوم في الإسلام، على قامة الأطفال ومجموعة من الأثار على الحمل والولادة وعلى نتائج ما بعد الولادة – تشـــمل على وجه التحديد الوزن عند الولادة ووفيات حديثي الولادة وبدء الرضـــاعة الطبيعية ومدتها وسلسلة من المضـاعفات أثناء الحمل والولادة. وبالنظر إلى أن نتائج الولادة وما بعدها يرتبط بطول فترة الحمل، يمكن اعتبارها دليلا على أثر التعرض لشهر رمضان على طول فترة الحمل. لقد استخدمت أنا بيانات من 98 عملية مسح ديموغرافي وصحي من 37 دولة منخفضة ومتوسطة الدخل ووجدت أن التعرض لشهر رمضان قبل الولادة يقلل من طول قامة ذكور الطفل المسلم بمقدار 12.2 ملم في المتوسط. لم تقدم فحوص النتائج الأخرى دليلاً قوياً على تأثير التعرض لشهر رمضان على طول فترة الحمل.

1. Introduction

A growing number of studies show that nutritional environment during gestation can affect a person's long-term health (Barker *et al.* 1990, Barker 1999, Gluckman and Hanson 2005). Childhood height is an informative indicator of gestational nutrition and can serve as a link between fetal nutrition and adulthood health. Particularly, the effect on height of a nutritional shock at a certain episode of gestation may predict the risk of specific health issues, such as cardiovascular heart diseases, in adulthood since the critical windows of development of the long bones— which lay the foundation for the growth in height— largely match to those for the heart (Karimi 2016). Accounting for timing of exposure to the shock *in utero*, in turn, requires evaluating the effect of the shock on the length of gestation. Information on length of gestation however is usually either unavailable or imprecise (Almond and Mazumder 2011, Mocan *et al.* 2015).

In this paper, I use exposure to the Muslim fasting month, Ramadan, as a natural experiment for a change in the pre-birth nutritional environment. Since the exposure may alter length of gestation, assignment of the exposure to a certain pre-birth episode is potentially erroneous in the lack of information on length of gestation. To approximate the effect on length of gestation, I measure the effect on a set of pregnancy, birth, and postpartum outcomes that are among the known correlates of length of gestation. My empirical analyses are focused on under 5 years old children for whom anthropometric measures and exact birth dates are reported in the USAID Demographic and Health Surveys (DHS). I use the DHS data from 98 surveys from 37 low or lower-middle income countries with at least a 10 percent Muslim population.

I find that pre-birth exposure to Ramadan negatively affects male children's height. The effect emerges at age 2 years and gradually becomes stronger and more statistically significant through ages 3 and 4 years. Particularly, 3 and 4 years old Muslim boys who were exposed to a full 30-day Ramadan *in utero* are on average 3.1–4.3 millimeters (mm) shorter than non-exposed Muslim and non-Muslim boys at the same ages. Examining the hypothetical situation in which the exposure is concentrated in different months shows that the peak of the height effect appears in the fourth month before birth. The negative effect on height of exposure at this month amounts to 11.2–12.2 mm on average at age 4 years. In general, exposure during the furthest months from birth, which encompass the critical windows of development of the long bones, is more consequential.

Overall negative effect of pre-birth exposure to Ramadan on male children's birthweight is small—about an average of 12 g (grams)—and statistically insignificant but increases to an average of 23 g if the exposure takes place in the mid-gestation. Pre-birth exposure to Ramadan has trivial to no effect on breastfeeding initiation and duration and also on the likelihood of neonatal death in the first day or month after birth. While it slightly increases the chance of maternal excessive bleeding and convulsion at birth, pre-birth exposure to Ramadan does not increase the chance of incidence of other maternal pregnancy, delivery, and post-delivery complications. There findings indicate that pre-birth exposure to Ramadan may have only a slim effect, if any, on the gestation period. Therefore, Ramadan-induced nutritional stress provides an opportunity to examine the long-term effects on health of a pre-birth nutritional shock by accounting for its timing, especially when information on the gestation period is unavailable.

This work contributes to the literature that studies the relationship between fetal nutrition and health in several ways. First, it provides a wide-ranging assessment of the health effects of pre-birth nutritional stress by examining various pregnancy, birth, postpartum, and childhood outcomes. Second, it addresses a common concern about the mis-assignment of a nutritional shock to different episodes of gestation, arisen from the lack of information on the gestation length. Third, it uses a large dataset of a diverse population from different countries located at different latitudes

and having varied economic structures, cultures, and climates to measure the effects of interest.

This paper is organized in six sections. In Section 2, the related literature and biological background are reviewed. In Section 3, the data and econometric models are introduced. In Section 4, the effect on height is presented. In Section 5, the effects on the correlates of length of gestation are discussed. Section 6 concludes.

2. Background

Nutritional shocks during the critical windows of fetal development can result in fetal adaptive responses to ensure that the brain receives the required nutrition. Prioritizing the brain nonetheless can hinder the development of other organs such as the kidney, heart, and components of the digestive system (Gluckman and Hanson 2005). The critical windows of development of the organs closely match to those of the long bones, which determine the ultimate height.[2] Such a close matching can potentially be used to predict the effect of a prenatal nutritional shock on the incidence of particular adulthood diseases: the effect of the shock on childhood height may signal the increased risk of incidence of the adulthood diseases (Karimi 2016). The proposition is in agreement with a large literature that finds strong correlation between height and morbidity and mortality from different diseases (Waaler 1984, Barker *et al.* 1990, Fogel *et al.* 1994, Jousilahti *et al.* 2000, Carslake *et al.* 2013).

To tease out the connection between a change in the prenatal nutrition and height, researchers have employed different exogenous shocks as natural experiment. Some examples are America's Dust Bowl, variations in rainfall in Indonesia, Ethiopian famine, Nigerian civil war, and El Nino floods in Ecuador (Cutler *et al.* 2007, Maccini and Yang 2009, Dercon and Porter 2010, Akresh *et al.* 2012, Rosales 2013). In such analyses, aside from the concern about endogeneity of the shock, its impact on length of gestation needs to be assessed. If it is suspected that the shock has a significant impact on length of gestation and it is not taken into account, then the analysis that relies on the timing of the shock is impaired.[3] If information on length of gestation is not available, then a study that uses an exogenous shock that is not drastic enough to change gestation length will not suffer from this.

Exposure to Ramadan may provide a suitable natural experiment if the exact timing of a prenatal shock is of interest.[4] First, the occurrence of Ramadan is generally considered exogenous to

[2] The long bones develop in four stages: (1) limb buds appear; (2) mesodermal condensation takes place along the limb buds; (3) cartilage models develop within the mesodermal condensations and primary ossification centers form simultaneously; (4) materialization process starts. The first three stages are steps toward formation of the long bones, starting from the last week of the first month of gestation and completing by the end of month 5. The last stage, on the other hand, is an expansionary step that follows the previous steps (Khurana 2009, Rose and Pawlina 2010, Karimi 2016). Kidneys, for example, develop in four stages as well: (1) initial kidney cells form and ureteric buds appear; (2) the ureteric buds and their connection develop while bifurcation inside kidneys takes place; (3) bifurcation process intensifies and the kidneys ascent from their early position; (4) the collecting duct system expands and completes. Similar to the development of the long bones, the first three stages of kidneys' development are formation steps, and the last step is an expansionary step. It is of particular interest that the timing of the formation and expansionary phases of kidneys' development closely coincide with those of the long bones. There are similar coincidences in the development of the heart, components of digestive system, and brain.

[3] In the lack of information on length of gestation, length of all gestations is usually assumed fixed and identical. In a hypothetical situation in which exposure to an early gestation shock reduces exposed individuals' length of gestation by one month while the non-exposed individuals' gestation period remains unchanged, any measured effect of exposure to the shock in the " assumed" month 5 of gestation, for example, is the result of comparing fetuses who are 4 and 5 months old and hence are at different stages of their development.

[4] Exposure to Ramadan can stress a fetus if the mother fasts or experiences dietary or sleeping disruption. The stress can decrease plasma glucose and alanine levels but increase ketone and cortisol levels in pregnant women (Metzeger *et al.* 1982, Dikensoy *et al.* 2009). Such changes are likely to have long-term developmental effects (Gluckman and Hanson 2005, Kapoor *et al.* 2006). Ramadan-induced nutritional stress can also hinder development of the long bones by limiting the transfer of calcium and vitamin D to the fetus *via* placenta (Gluckman *et al.* 1996, Cooper *et al.* 2006).

parents' and household's characteristics (Almond and Mazumder 2011, van Ewijk 2011, Almond *et al.* 2011, Majid 2012, Schultz-Nielsen *et al.* 2016, Karimi 2016).[5] Second, observational studies have not found evidence of a connection between Ramadan fasting and length of gestation (Salleh 1989, Kavehmanesh and Abolghasemi 2004, Mirghani and Hamud 2006, Ziaee *et al.* 2010, Bloomfield 2011, Awwad *et al.* 2012, Karanteke *et al.* 2015). Although obtaining an unbiased measurement of the effect from observational studies is not guaranteed, evidence from studies that use exposure to Ramadan as a natural experiment shows that it has negligible effect on the gestation period (Almond and Mazumder 2011).[6],[7]

Nevertheless, the assumption that exposure to Ramadan has no or insignificant effect on the gestation period may depend on the context. Almond and Mazumder (2011) use data from Muslims living in Michigan, USA, but the observance of Ramadan can potentially be different in different countries, then the effect on the gestation length may vary from one country to another. The lack of information on length of gestation however has forced researchers to assume a fixed length for all gestations without empirically testing the strength of the assumption (van Ewijk 2011, Almond *et al.* 2011, Majid 2012, Karimi 2016).

To overcome the lack of information on the gestation length, outcomes that are related to the gestation length can be examined. Information such as birthweight, neonatal death, breastfeeding initiation and duration, and a series of maternal complications during pregnancy and at or after delivery are available in the DHS data. Birthweight, neonatal death, and breastfeeding initiation and duration are factors that are affected by length of gestation. In other words, if exposure to Ramadan affects length of gestation, then one would expect to notice its effect on these outcomes as well. On the other hand, pregnancy and delivery complications are factors that affect length of gestation. Hence, detecting an effect of exposure to Ramadan on these factors may point to a shortened gestation. In the following, connection of these variables to length of gestation is reviewed in the related medical literature.

– Length of gestation and birthweight

Length of gestation and fetal growth are the two major determinants of the birthweight (Donahue *et al.* 2010). Amini *et al.* (1994) show that more than 80% of variations in birthweight are, in fact, explained by the gestational age. Therefore, the birthweight and length of gestation have usually been used as parallel outcomes in measuring the impact of mothers' exposure to potential risk and stress such as lead, caffeine intake, and employment during pregnancy (Factor-Litvak *et al.* 1991, Beck *et al.* 2007, Casas *et al.* 2015).

– Length of gestation and neonatal death

The highest risk of child mortality is in the neonatal period— *i.e.*, the first 28 days after birth— such that child death during this period constitutes about 45% of all deaths under the age of 5 years.[8] The first week of neonatal period is the most vulnerable week, during which about 75% of

[5] Almond and Mazumder (2011) measure the effect of prenatal exposure to Ramadan on newborn Arabs' birthweight in the State of Michigan and on disability in adulthood in Iraq and Uganda; van Ewijk (2011) measures its effect on general health in Indonesia; Almond *et al.* (2011) measure its effect on Pakistani and Bangladeshi children's educational performance in England; Schultz-Nielsen *et al.* (2016) measure its effect on labor market outcomes of Muslims in Denmark; and Karimi (2016) measures its effect on birthweight and childhood height in a pool of 35 developing countries.

[6] Almond and Mazumder (2011) use length of gestation information and find that exposure to Ramadan during pregnancy may decrease its length only by about one day.

[7] Examining the effect on the gestational age of other nonradical changes in the prenatal nutritional environment has also shown little negative effects. For example, Mocan *et al.* (2016) use the U.S. birth records from 1989 to 2004 and show that a 50 percent increase in earning for a low-skill unmarried pregnant American mother increases her child's gestational age by about 2 days.

[8] The World Health Organization (WHO) media centre fact sheets at: http://www.who.int/mediacentre/factsheets/fs178/en/

neonatal mortality happens (Lawn *et al.* 2005). In the first week, the first day is the most susceptible day, during which about half of all neonatal deaths take place (Lawn *et al.* 2005, Lawn *et al.* 2010). Among the direct causes of neonatal death, preterm birth is the most blamed one that accounts for about a third of neonatal deaths (Lawn *et al.* 2005). In general, there is a reversed J-shaped continuous relationship between neonatal mortality and gestational age (Ananth and Platt 2004).[9]

– Length of gestation and breastfeeding

Breastfeeding initiation rate and its duration are generally lower for children who are not born full-term (Donath and Amir 2008, Lutsiv *et al.* 2013). Donath and Amir (2008) use a longitudinal survey of Australian children and show that the odds of being breastfed by month 6 after birth significantly drop when length of gestation decreases. More specifically, the odds are 80% and 51% for children born during weeks 37–39 and 35–36 of gestation, respectively, when compared to children born during week 40. Lutsiv *et al.* (2013) conduct a population-based study in Ontario, Canada and show that the odds of breastfeeding initiation before hospital discharge significantly drop as length of gestation decreases. Particularly, the odds are 93%, 87%, 81%, and 74% for children born during weeks 40, 39, 38, and 37 of gestation, receptively, when compared to children born during week 41. Findings of studies that exclusively examine preterm children are also in line with the findings of the aforementioned studies that focus on late preterm and early-term children (Espy and Senn 2003, de Freitas *et al.* 2016).[10]

– Length of gestation and maternal delivery and postpartum complications

Maternal pregnancy and delivery complications can potentially result in a delivery before its term. In the DHS data, four types of birth complications are often reported: prolonged labor, uterus infection, excessive bleeding, and convulsion. A reported prolonged labor can be viewed as a sign of shortened gestation period because it often requires labor induction and cesarean birth then results in late preterm or early-term delivery (Bhatta and Keriakos 2011).[11] If mothers' characteristics are considered, increased fetal growth, or macrosomia, is one of the key causes of prolonged labor (Lowe 2007, Astrid and Hildingsson 2014). A well-accepted cause of Macrosomia, in turn, is gestational diabetes (Cunningham 2001, Stotland *et al.* 2004, Sweeting *et al.* 2016). There is clinical evidence that Ramadan fasting increases the risk of gestational diabetes (Mirghani and Hamud 2006). Therefore, a possible channel of the effect of exposure to Ramadan on prolonged labor, if any, can be through gestational diabetes and macrosomia.

Reported maternal excessive bleeding during or after birth and uterus infection after birth can also be viewed as signs of delivery before its full term.[12] Fetal macrosomia, prolonged labor, and induction of labor are among the known causes of excessive bleeding at or after birth (Bais *et al.* 2004, Breathnach and Geary 2009). Uterus infection is mainly affected by the mode of delivery, such that its prevalence in cesarean is significantly higher than that in normal deliveries (Goldenberg and Andrews 1996, Chaim *et al.* 2000, Olsen *et al.* 2009).[13] Considering the risk factors for excessive bleeding and uterus infection, the mechanism of the effect of Ramadan on

[9] Ananth and Platt (2004) also show that there is a similar reversed J-shaped relationship between length of gestation and birthweight, which is the key indirect cause of neonatal death.

[10] According to the American College of Obstetricians and Gynecologists (ACOG) deliveries that take place before the 37th week, between weeks 35–36, and between weeks 37-39 of gestation are called preterm, late preterm, and early term, respectively (ACOG 2013).

[11] Prolonged labor is also called dystocia.

[12] Excessive bleeding and uterus infection are called postpartum hemorrhage and postpartum endometritis, respectively.

[13] Uterus infection is 1–3%, 5–15%, and 15–20% prevalent in normal, scheduled cesarean, and unscheduled cesarean deliveries, respectively (Moldenhauer 2016).

them is similar to that on prolonged labor.

A reported maternal convulsion, which is usually combined with maternal hypertension, at or after birth can also be viewed as a sign of decreased length of gestation.[14] Since there is no effective treatment for convulsion, and it can harm the fetus and mother, induced delivery is usually considered a treatment choice when convulsion occurs (Sibai *et al.* 2006). Perhaps not surprisingly, empirical studies find an association between convulsion and shortened gestation (Koopmans *et al.* 2009 and Sibai 2011). There is weak clinical evidence of the effect of Ramadan fasting on pregnant women's blood pressure, which can potentially increase the risk of convulsion at delivery (Awwad *et al.* 2012, Jamilian *et al.* 2015).

– Length of gestation and pregnancy complications

Maternal complications during pregnancy can potentially reduce the gestation period. In the DHS data, three questions about pregnancy complications are often answered. The questions ask about the experience of any of the following complications during the last pregnancy the led to a live birth: (1) bleeding; (2) headache, blurry vision, or abdominal pain; and (3) night blindness.

Bleeding earlier in a pregnancy is not necessarily a complication, but its occurrence later in pregnancy can be a sign of labor and lead to delivery before its full term (Nicholson *et al.* 2001, Sharami *et al.* 2013).[15] Majority of the studies that investigate the effect of bleeding during pregnancy on the gestation length find a negative effect although it is usually a modest one (Ananth and Savitz 1994, Yang *et al.* 2004). Risk factors for pregnancy bleeding are mostly unknown, but it can be a symptom of uterus inflammation or infection (Yang *et al.* 2004). Clinical studies of Ramadan have not reported its effect on bleeding.

Headache, blurry vision, and abdominal pain are also common and considered normal during pregnancy, but they sometimes manifest complications that can result in a shortened gestation. Each of the three can be a sign of preeclamsia and high blood pressure, but blurry vision and abdominal pain are also symptoms of gestational diabetes and urinary track infection, respectively (Kennedy 2000, Seth and Mieler 2001, Digre 2013). Clinical studies have connected all of the three factors to preterm delivery (Seth and Mieler 2001, Nair 2005, Adeney and Williams 2006, Marozio *et al.* 2012). Clinical studies that examine the effect of Ramadan fasting on maternal blood pressure have not found a statistically significant effect although high blood pressure was more prevalent among fasting pregnant women than non-fasting ones (Awwad *et al.* 2012, Jamilian *et al.* 2015).

Night blindness during pregnancy is usually caused by vitamin A deficiency and is more common in developing countries (Christian *et al.* 2000, Tielsch *et al.* 2008). It is shown that women who experience night blindness due to vitamin A insufficiency during pregnancy have a higher chance of giving birth to low birthweight children (Tielsch *et al.* 2008). Since low birthweight can be a sign of reduced gestation period, and it is shown that exposure to Ramadan reduces birthweight, reported night blindness may also signal the effect of exposure to Ramadan on length of gestation (Almond and Mazumder 2011, Majid 2012).

[14] Convulsions after child birth are usually considered preeclampsia or eclampsia, which are types of hypertension that is induced by pregnancy. Its symptoms are high blood pressure, edema and the presence of protein in urine (ACOG 1996, Dutta *et al.* 2006).

[15] When bleeding has happened during pregnancy is not specified in the DHS data. The DHS data also does not report the number of episodes of bleeding and the amount of blood loss, which both are relevant to the effect of bleeding on length of gestation.

3. Data and Econometrics Model

3.1 Data

I use children information from 98 DHS surveys, representing 37 countries, in the empirical analyses.[16] I started with 117 DHS surveys from 45 low and lower-middle income countries that have at least a 10% Muslim population, but I dropped 19 surveys in which no information on children's exact birth date and mothers' religion is available. The remained 98 surveys provide a pool of 900,811 children from 37 countries.[17] In each of the 98 surveys, there are children with and without exact birth date. More specifically, the exact birth date is missing for about 37% of children in the pool. Socioeconomic characteristics of children with and without exact birth date are different. Children without birth date tend to be from families with less educated parents, from rural areas, Muslims, poorer, and shorter in height at all ages (Table 1).[18]

According to the requirements of different analyses presented in the paper, I select different subsamples of the large sample. For example, in the height analyses in which the outcome variable is height-for-age Z-score, I use a subsample that contains children's height, its exact measurement date, and exact birth dates. When I analyze birthweight, the key sample selection constraint is the availability of the birthweight and exact birth date. However, when I analyze neonatal mortality, I no longer limit the sample to children with exact birth date because deceased children's day of birth is not reported in any of the surveys.

To study the effect on height, I started with the subsample of 565,360 children with exact birth date. I dropped children for whom height or exact height measurement date is missing or height-for-age Z-score falls outside of [–6,6] range, which left 510,718 children in the sample.[19] Then, I dropped twin births, 13,829 cases, because twin children's growth curve is different from that for singleton children. The availability of control variables further restricted the sample: successive additions of constraints on the availability of information on province or state of residence in the pertinent country, household wealth, mother's height, mother's education and age, father's education, and father's age resulted in dropping 1,321, 17,057, 40,263, 4,578, 18,471, and 46,391 children, respectively.[20],[21] These constraints decreased the sample to 368,808 children. In the last step, I dropped observations for which there are discrepancies between height measurement and

[16] The DHS Program conducts nationally representative population and health surveys in developing countries then organizes and publicizes the data. The program is implemented by ICF International and financed by the USAID, the United States Agency for International Development (See: http://dhsprogram.com/Who-We-Are/About-Us.cfm).

[17] Most of the countries are low or lower-middle income, measured by 2015 GNI per capita by the World Bank, countries. The low income countries are Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Ethiopia, Guinea, Liberia, Malawi, Mali, Mozambique, Niger, Senegal, Sierra Leone, Tanzania, Togo, and Uganda. The lower-middle income countries are Bangladesh, Cameroon, Egypt, Ghana, India, Ivory Coast, Kenya, Kyrgyzstan, Morocco, Nigeria, Pakistan, and Uzbekistan. However, seven other countries— Albania, Azerbaijan, Gabon, Jordan, Kazakhstan, Maldives, and Turkey— are among the upper-middle income countries (See: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). More than 96 percent of observations are from low or lower-middle income countries.

[18] A controlled correlation examination shows that if an alive child's mother's and father's education increase by one level, then the likelihood of reporting the child's exact birth date increases by about 4.0 and 1.3 percentage points, respectively. Also, being Muslim and moving from one wealth quintile to a lower one decrease the likelihood of reporting a child's exact birth date by about 3.5 and 2.4 percentage points, respectively. The estimated associations, which are statistically significant, are conditional on holding other covariates constant. The likelihood of reporting exact birth date for a Muslim child is on average about 11.2 percentage point less than that for a non-Muslim child whose parents' education and wealth are higher by one level.

[19] To have uniform height-for-age Z-scores across countries and through time, I recompute children's height-for-age Z-score by employing the WHO 2006 age- and sex-specific Child Growth Standards, available at http://www.who.int/nutgrowthdb/en/, as the reference population.

[20] I use information provided in variables that can indicate a household's wealth and are provided in all DHS surveys to generate a consistent indicator of wealth across counties and through time. The variables are (1) source of drinking water, (2) type of toilet, (3) main material of the floor, (4) access to electricity, (5) ownership of radio, and (6) ownership of TV.

[21] I also drop children whose mothers' height falls outside the [120,190] centimeters range to count out outliers and reporting and measurement errors.

interview dates. The latter further downsized the sample to 308,879 observations.[22] In Table (2), the distribution of observations are presented by country, mother's religion, and children's sex.

Similar to height analyses, in the analyses of birthweight, breastfeeding initiation and duration, and pregnancy and birth complications, I included only alive singleton children with exact birth date. In each case, after dropping children for whom the outcome variable of interest is missing, the data trimming and cleaning process was exactly similar to that for height analyses described above.[23] In Appendix A, distributions of observations used in these analyses are presented by country, mother's religion, and children's sex (Tables A.1–A.10).

In the large sample, there are 73,017 deceased children— 33,404 of them died as a neonate— whom are considered in the analyses of neonatal mortality. Exact birth date is not reported for deceased children. For consistency, I included alive children without exact birth date alongside alive children with exact birth date in the sample. The rest of the data trimming and cleaning process was similar to that for other outcomes. In Appendix A, the distribution of alive or deceased children for whom control variables are not missing is presented by country, mother's religion, and children's sex (Table A.2).

3.2 Exposure measures

I assume a normal 270-day gestation length for every child and go backwards from the child's exact birth date to determine if the child's gestation was coincided with Ramadan. If it did, then I determine the number of days of coincidence, or exposure, during the entirety, trimesters, and months of gestation (Figure 1). For most of the analyses, exact birth dates are available, but dividing the presumed gestation period into trimesters and months becomes more uncertain when only year and month of a child's birth are available, which is the case when neonatal mortality is studied. In the latter case, I consider three episodes: two episodes of uncertain exposure in the beginning and at the end— namely, birth and conception months— and one episode of likely exposure in the middle of gestation (Figure 2).[24]

After finding the number of days of exposure to Ramadan, I find hours of exposure during the predetermined episodes of gestation. Hours of exposure to Ramadan in a specific episode are the summation of hours of exposure in each day of exposure in the episode. Hours of exposure in a Ramadan day is the number of daylight hours in the day since the fasting time in a Ramadan day is in exact accordance with daylight hours. Daylight hours of an exposure day, in turn, are calculated based on when the day is positioned in the corresponding year and the latitude of the

[22] For about 15% of children with reported height, dates of height measurement and interview do not match. In about 80% of these cases, measurement date is a date before interview. These children are in average shorter than those whose measurement and interview dates are identical. The reason for the discrepancy is unclear, but one possibility is that height is transferred from health cards, which are issued before interview.

[23] Checking the mismatch of height measurement and interview dates is irrelevant for these outcomes.

[24] Even when the exact birth dates are used, the assignment of exposure is not certain in the lack of information on length of gestation. Unavailability of exact birth date adds to the uncertainty. In the month of birth, there are potentially 0, 1, 2, ... , or 30 days of exposure, depending on the day of birth and the timing of the coincidence of Ramadan with the birth month. As an example, consider two children who are born in the same year and month, but their days of birth are not reported. Also, suppose that a Ramadan started in the 15th day of their birth month. If one of the children was born in the 10th day of the birth month, then the child is actually not exposed to Ramadan *in utero*. If the other child was born in the 25th day of the birth month, then the child is exposed to 10 Ramadan days *in utero*. I nonetheless assume that both of them are exposed to 15 Ramadan days during their birth month. Similarly, the assignment of exposure to the presumed month of conception is uncertain. However, the assignment of exposure is less uncertain in the time period from the month right after the presumed conception month to the month prior to the birth month.

place of residence.[25] In the followings, the hours of exposure measures are listed.[26] These measures are used in all analyses but neonatal mortality.

$HER270_{it}$: hours of exposure to Ramadan during the 270-day period before birth

$HER190_{it}$: hours of exposure to Ramadan during the first 90-day period before birth

$HER290_{it}$: hours of exposure to Ramadan during the second 90-day period before birth

$HER390_{it}$: hours of exposure to Ramadan during the third 90-day period before birth

$HER130_{it}$: hours of exposure to Ramadan during the first 30-day period before birth

$HER230_{it}$: hours of exposure to Ramadan during the second 30-day period before birth

$HER930_{it}$: hours of exposure to Ramadan during the ninth 30-day period before birth

3.3 Identification strategy and econometric specifications

To tease out the effect of prenatal exposure to Ramadan on children's height and other outcomes, I use variations in the timing of exposure to Ramadan *in utero* and in religion. The identification strategy then does not use variations in the observance of Ramadan, which is unknown and potentially endogenous. Variations in the exposure to Ramadan are perceived to be exogenous instead. In other words, it is as if the assignment of treatment (*i.e.,* exposure) is random, but the willingness to be treated (*i.e.,* observance) is not random. Therefore, the measured effects present the intent to treat (ITT), or reduced form, effects.

The identification strategy thus relies on two identification assumptions: (1) exposure to Ramadan *in utero* is exogenous and (2) length of gestation is identical for all live births. The summary statistics of the children's and their parents' observable characteristics provides preliminary evidence on the validity of the first assumption. In Table (3), Panel A, means and standard deviations of the characteristics are presented by children's sex, their mothers' religion, and the level of exposure. Although there are differences among Muslim and non-Muslim children in terms of their parents' education and household's rate of urbanization, the presented characteristics— birth order, parents' age at birth and education, mothers' height, and households' rate of urbanization— do not change by the intensity of exposure in each group. More careful examinations of the validity of the assumption of exogeneity of exposure to Ramadan, provided in Appendix B, show no systematic bias into exposure by setting the timing of conception according to the occurrence of Ramadan.

The validity of the second assumption— that length of gestation is fixed— is investigated in Section (5) where the effects of exposure to Ramadan on an array of length of gestation correlates are examined. As will be discussed, the results hint at no significant difference between distributions of length of gestation in the exposed and non-exposed groups. Therefore, although length of gestation is unknown, exposure to Ramadan is unlikely to affect the assignment of exposure to the presumed episodes of fetal life. Nonetheless, since it is not certain that month 9 before birth, for example, is the first month of gestation, I use adjective" pre-birth" to describe the time intervals.

---

[25] Latitude of the place of residence of a household is given in the *Geographical Database*, a package provided with most of the DHS surveys. When the package was not provided, I found the pertinent latitude in the Google Maps using city or town of residence information.

[26] As a part of robustness tests, I use other measures of exposure to Ramadan— namely, days and dummies of exposure—. Those measures are labeled similarly. For example, $DER270_{it}$ and $ER270_{it}$ indicate days and dummy of exposure to Ramadan during the 270-day period before birth, respectively.

Non-Muslims are included in the analyses for falsification tests and to account for seasonal effects. Ramadan does not occur at a certain time every year; it circulates and occurs about 11 days earlier each year, so that a full circulation takes about 32 years. Hence, seasonal effects can potentially confound the effect of interest. My large dataset that includes 30 birth cohorts guarantees that the seasonal effects are controlled.

Means of children's height-for-age Z-score reveal signs of the effect of exposure to Ramadan: as the exposure intensifies from none to 30 days, height-for-age Z-score of Muslim boys decline, especially later in childhood (Table 3, Panel B). However, it is difficult to discern a pattern of effects by the intensity of exposure for girls. Thus, similar to Karimi (2016), I specify sex- and age-specific econometric models in which relevant background covariates, which are extensively available in the DHS data, are controlled. I estimate three econometric models for each of the 10 sex-age groups of children—*i.e.*, $(s,a) = (boy,0),(boy,1),...,(boy,4),(girl,0),(girl,1),...,(girl,4)$:

$$HAZ_i = \alpha^{s,a,M} + \beta^{s,a,M} exposure_i + \delta^{s,a,M} X_i + \varepsilon_i^{s,a,M} \quad (1)$$

$$HAZ_i = \alpha^{s,a,N} + \beta^{s,a,N} exposure_i + \delta^{s,a,N} X_i + \varepsilon_i^{s,a,N} \quad (2)$$

$$HAZ_i = \alpha^{s,a} + \beta^{s,a}(exposure_i \times MUSLIM_i) + \rho^{s,a} exposure_i + \delta^{s,a}(X_i \times MUSLIM_i) + \sigma^{s,a}.X_i + \mu^{s,a} MUSLIM_i + \varepsilon_i^{s,a} \quad (3)$$

where i, s, a, M, and N indicate a child, the child's sex ($s = boy, girl$), the child's year(s) of age ($a = 0,1,2,3,4$), Muslim, and non-Muslim, respectively. Variable HAZ is the child's height-for-age Z-score, and $exposure$ is a set of hours of exposure measures such as $\{HER270_i\}$, $\{HER190_i, HER290_i, HER390_i\}$, or $\{HER130_i, HER230_i, ..., HER930_i\}$. Vector X contains control variables, namely the child's age in days, year of birth, month of birth, birth order, an urban/rural indicator, a country indicator, a province indicator, parents' age at the child's birth, parents' education level, mother's height, and household's wealth indicator.[27] Variable $MUSLIM$ indicates if the the child's mother is Muslim. To account for clustering effects, I cluster standard errors at the country level.[28]

In Model (1), where the effect of exposure to Ramadan on height-for-age Z-score for a sex-age group of children is measured by $\beta^{s,a,M}$, only Muslim children are included. In Model (2), where the effect of interest is measured by $\beta^{s,a,N}$, only non-Muslim children are included. Model (3), which uses both Muslims' and non-Muslims' information, measures the Muslim *versus* non-Muslim differential effect of exposure to Ramadan by $\beta^{s,a}$. The latter includes a full set of interaction terms. Then, the following equality connects it to the former models: $\beta^{s,a} = \beta^{s,a,M} - \beta^{s,a,N}$. In most cases, the models are estimated by the ordinary least squares (OLS) method, but in some cases the fixed-effect (FE) method is used as well.

4. The effect on height[29]

I estimate Models (1)–(3) for each sex-age group using the three sets of exposure measures— *i.e.*,

[27] A parent's education level is categorized under any of the following six categories: no education, incomplete primary, complete primary, incomplete secondary, complete secondary, and higher.

[28] The levels of statistical significance are robust to the level of clustering such as country-province, year, year-country, and year-country-province. Using an alternative method, namely multilevel analysis at the levels, provides similar results.

[29] The STATA codes used to organize each survey, clean and refine the pooled workfile, calculate Z-scores, estimate the econometric models, and test alternative explanation are available, and I can provide them to researchers upon request.

exposure during the 270-day period before birth and its 90-day and 30-day sub-periods— using the OLS method. The estimated effects are reported in Appendix C (Tables C.1–C.4). Each entry of the tables is the average effect on the height-for-age Z-score of an hour of exposure to Ramadan during the corresponding pre-birth episode in a group of children specified by age, sex, and religion. The results show that the height is not negatively associated with pre-birth exposure to Ramadan in female children.[30] In male children however the two are negatively associated.[31] Additionally, the effect on male children's height presents a specific pattern: the negative effect surfaces at age 2 years and progressively becomes stronger and more statistically significant by ages 3 and 4 years.[32] Also, the timing of appearance of the strongest effects coincides with the critical windows of development the long bones.

While the relative size, statistical significance, and pattern of the effects on the height-for-age Z-score can be discerned in Tables (C.1)–(C.4), converting the effects to millimeters and graphically illustrating them will be more revealing. Figure (3) shows ranges of the effect of exposure to a full month of Ramadan on height at different pre-birth episodes at ages 3 and 4 years when exposed and non-exposed male Muslim children are compared.[33] Figure (4) shows the ranges of effect on height when exposed male Muslim children at the ages are compared to both non-exposed Muslim and non-Muslim male children.[34]

Figures (3) and (4) show that exposure to a full 30-day Ramadan during the 270-day period before birth is associated with a 1.0 to 4.3 mm decrease in height, depending on the age and level of comparison. The effect is stronger at age 4 years or when Muslims are contrasted to non-Muslims. When trimesters of the 270-day period are considered, the strongest negative effect appears earlier in the presumed gestation—*i.e.*, either in the second or third trimester before birth— and amounts to an average 7.5 mm. The importance of early- and mid-gestation exposure is further verified when the effect in monthly episodes is measured. For example, the negative height effect can amount to an average 12.2 mm if a full exposure occurs in month 4 before birth.[35]

---

[30] Some positive effects on female children's height at age 1 can be detected. The effects however do not persist to ages 2, 3, and 4 years. Therefore, they do not present a pattern that is consistent with the dynamics of growth in height, which tends to preserve and intensify the effects of earlylife nutritional shocks.

[31] Males' disadvantages in affliction, sometimes framed as selective male misery or fragile male hypothesis, are documented by clinical studies (Kraemer 2000). Sex differences in vulnerability to adversities are more pronounced during gestation (Loke 1978, Gualtieri and Hicks 1985, Lavoie *et al.* 1998). Most studies that document evidence of sex differences in bearing *in utero* shocks use sex ratio at birth as the outcome of interest (Lyster 1974, Fukuda *et al.* 1998, Hansen *et al.* 1999, Zorn *et al.* 2002). Almond and Mazumder (2011) show that prenatal exposure to Ramadan is associated with up to 6.6 percentage point decrease in the likelihood of a male birth among Muslims in Michigan, USA. Karimi (2016) also finds sex-specific effects on children's height.

[32] Consequences of fetal life restrictions may not be apparent immediately after birth (Gluckman and Hanson 2005). Late realization of the effects is documented in other studies as well (Kusin *et al.* 1992, Roseboom *et al.* 2000, Eriksson 2006). More importantly, Kusin *et al.* (1992), who have recorded height and weight effects of a randomized prenatal nutritional supplementation in the first five years of life, observe that height difference between treatment and control groups broadens while weight difference shrinks by age.

[33] To find each range, first I multiply the pertinent estimated coefficient by 360 ($=12\times30$) because an exposed child in the sample experienced Ramadan days that were about 12 hours long on average. The coefficient of interest is under column" Muslim" in Tables (C.1)–(C.4). The resulted number is the estimated effects of a full 30-day exposure to Ramadan on height-for-age Z-score. The smallest unit of exposure to Ramadan is a day. Therefore, by multiplying the coefficient by 30, I assume that the effect of exposure to Ramadan on height is linear with respect to the number of days of exposure (Results of examining alternative measures of exposure to Ramadan, discussed in Appendix D, show that is not a strong assumption). Finally, I transform the latter number to millimeters by multiplying it by the standard deviation of a male child's height at the first and last days of the pertinent age in the reference population.

[34] Each range is found in a similar way to those in Figure (3), but the estimated coefficients are the ones under column " All" in Tables (C.1)–(C.4).

[35] Ramadan's effect on height is smaller than the effect of sharper shocks such as famines. For example, Dercon and Porter (2010) find that birth during the peak of the 1984 Ethiopian famine resulted a 30 mm drop in children's height. Ramadan effect however is comparable to the effect of earlylife family income shocks. For example, Banerjee *et al.* (2010) find that birth during

The pattern of the effect is noteworthy. The critical windows of development of the long bones fall in the first and second trimesters of gestation These stages of the long bones' development complete by the ends of month 5 of gestation. By that time, the primary ossification centers in the long bones have formed; they only expand and materialize afterwards. I focus on age 4 years, the age at which a child's height has a closer resemblance to the child's ultimate height than the height at age 3 years. Figure (3), Panel B, in which exposed and non-exposed 4-year-old Muslim boys are compared, shows that the negative effect is at its greatest magnitude at month 7 before birth, which presumably is month 3 of gestation when the long bones' cartilage models form and develop at the highest rate. The magnitude of the effects gradually decrease from then such that it becomes zero by the month just before birth. The pattern of the effect in Figure (4), Panel B, when exposed 4-year-old Muslim boys are compared to their non-exposed Muslim and non-Muslim counterparts, is not as distinct as the pattern in Figure (3), Panel B. Nonetheless, the strongest effect still appears early and tends to diminish when approaching birth.

Figures (3) and (4) show that the effect on height of exposure to Ramadan during month 9 before birth is strong and statistically significant regardless of age and level of comparison. Months 9 before birth, presumably the month of conception, has only a short overlap with a critical window of development of the long bones. The relatively large effects can be caused by mothers' higher rate of observance of Ramadan in the first month of pregnancy because of their unawareness to the pregnancy or the lower burden of fasting.

In a series of robustness tests, I check how the effects on height change when countries with a large share of observations are dropped, the heaping points of the birth day are dropped, alternative exposure measures are used, fixed-effect estimation method is applied, and pre-conception and post-birth exposure measures are included. The results, presented and discussed in Appendix D, show that the sign and pattern of the effects remain unchanged although the sizes of the effects moderately change.[36]

5. The effect on the correlates of length of gestation

In the analyses of height, I assumed a fixed 270-day gestation for all children. However, exposure to Ramadan can potentially change length of gestation and if the change is not taken into account, then comparing the height of non-exposed children to that of children who were exposed during month 4 before birth, for example, is not justifiable since the two groups of children were at different stages of their fetal lives. This consideration is especially important when the timing of exposure is intended to be used to deduct the long-term effects on health from the effects on height. In the followings, I test how strong the fixed-gestation assumption is by examining the effect of pre-birth exposure to Ramadan on a host of pregnancy, delivery, and post-birth outcomes that are among the known correlates of length of gestation.

5.1 Birthweight

Exposed and non-exposed Muslim boys' average birthweights are 3,184 and 3,181 grams,

the 1863–1890 pest attacks to French vineyards was associated with 6–10 mm decline in height at age 20 years. Also, Maccini and Yang (2009) find that birth during a year with 20% more rainfall in rural Indonesia was associated with a 5.7 mm height increase in women. The latter shocks usually result in constant low food intake; whereas Ramadan results in disruptions in food intake. The measured Ramadan effects are more severe than the effects of most other shocks that cause disruptions in food intake. For example, the effects are greater than those measured by Rosales (2016), examining the effect on height of the 1997–1998 El Nino floods in Ecuador.

[36] Although I have not reported the results, I have examined the robustness of the effects to two more tests and found no significant change in their sign and pattern. In the first test, I drop surveys in which a significant number of observations (at least 20, 30, 40, or 50 percent) lack the exact birth date and reestimate the effects. In the second, I drop pre-2000 surveys, which have a slightly different format, and reestimate the effects.

respectively; for exposed and non-exposed Muslim girls, the averages are 3,080 and 3,091, respectively. While exposed and non-exposed children's average birthweight differences are not statistically significant, I further investigate the birthweight effect of exposure to Ramadan in controlled regressions. First, I assume a fixed 270-day length for all gestations and run OLS and fixed-effect regressions. Second, I change length of gestations to 210, 240, and 300 days, run OLS and fixed-effect regressions, and compare the results.[37]

Table (E.1.1) in Appendix E.1, presents the estimated effects on birthweight of exposure to Ramadan when length of gestation is set 270 days. I multiply them by 360,000 to obtain the effects of full 30-day exposure to Ramadan and visualize the effects.[38] Figure (5), visualizing the OLS results, shows that the effect of pre-birth exposure to Ramadan on male and female children's birthweight is generally negative but mostly small in size and statistically insignificant. More specifically, the results show that full exposure to Ramadan during the 270-day period before birth is associated with an average 11 and 12 grams decrease in male and female children's birthweight, respectively. While the effects are hardly statistically significant, full exposure during the second and third trimesters before birth, for male and female children, respectively, has near statistically significant effect, which on average amount to 23 grams. The effects however disappear in the fixed-effect regressions.

The first set of examinations show some weak, if any, effect of exposure to Ramadan on birthweight. The question is whether the measured effects are signs of shortened gestation given the close association of birthweight and length of gestation. As a test, I check the pattern and sizes of the effect on birthweight of exposure to Ramadan during 30-day episodes (months) before birth. I start with assuming a 7 months (210 days) gestation for all children and gradually add a month to gestations up to 10 months. The results for male children, presented in Table (E.1.2) in Appendix E.1, show that regardless of the assumption on length of gestation, exposure during months 1 and 5 before birth have statistically significant, or close to statistically significant, adverse effect on male children's birthweight in OLS estimations. A consistent pattern is observed in fixed-effect estimations as well: again, regardless of the assumption on length of gestation, exposure during months 1 and 7 before birth have statistically significant, or close to statistically significant, negative effect on male children's birthweight. More importantly, sizes of the effects for each of the pre-birth months only slightly change when the assumption on the gestation length is changed.[39] Measuring almost identical effects on birthweight of exposure during specific pre-birth months regardless of the assumption on length of gestation indicates that the months represent a specific episodes of fetal development. This plus the substantial change in the size of the effect of exposure during the pre-birth months when length of gestation is assumed to be 10 months may suggest that length of gestation the exposed and non-exposed children is the same.

5.2 Neonatal mortality

There are 22,639 alive born children who were deceased before the age of 5 years and have all of the required information to qualify for the analyses presented in this section.[40] Among them,

[37] In Table (A.1) in Appendix A, the distribution of observations in the birthweight analyses is presented by country, survey, religion, and sex.

[38] 360,000 is the result of multiplying 12 (average daylight hours during a Ramadan in the sample) by 30 (number days of a typical Ramadan) and 1,000 (to change kilograms to grams).

[39] Similar results are found when female children's birthweight is examined, although they are not reported. For female children, regardless of the assumption on length of gestation, exposure during months 4 and 7 before birth in OLS regressions and during months 2 and 4 before birth in fixed-effect regressions always has statistically significant, or close to statistically significant, adverse effect on female children's birthweight.

[40] Table (A.2) in Appendix A, shows the distribution of observations in the analyses presented in this section by country, survey, religion, and sex.

11,101 (about 49 percent) died as neonates (in the first 30 days after birth), of which 9,898 (about 89 percent) happened in the first day after birth. Given the particular vulnerability of children during the first day and month after birth in the sample, I examine the effect of pre-birth exposure to Ramadan on the likelihood of death at these times. Also, since neonate death and length of gestation are closely associated, I examine the effects under three scenarios: when length of gestation is assumed to be 7, 8, and 9 months.

Since the deceased children's day of birth is not reported in any of the surveys, I distinguish three pre-birth periods: conception month, mid-gestation months, and birth month. Depending on when the birth day was, a deceased child might or might not have been exposed to a Ramadan during the month of birth. This uncertainty in assignment of exposure carries over to the month of conception, but it is more likely that exposure is correctly assigned during the middle months of gestation.[41] To be consistent, I treat currently alive children, whose birth day is available, as if their days of birth is not available.

The results of estimating linear probability models for the effect of exposure to Ramadan on neonatal mortality are presented in Tables (E.2.1) and (E.2.2) in Appendix E.3. Each entry of the tables is the effect of an hour of exposure to Ramadan during the three periods and under each scenario when exposed Muslim children are compared to non-exposed Muslim and non-Muslim children. If length of gestations is assumed to be 9 months, then exposure during conception month has statistically significant effect on male children's death in both first day and month after birth. Assuming a partial exposure during the conception month, the size of the effect on the likelihood of a male child's death in the first day and month of life are on average 0.36 and 0.49 percentage points, respectively.

The effect on male neonate death however is not preserved in fixed-effect regressions. Also, under both methods of estimation, the effects disappear when length of gestations are reduced to 8 or 7 months.[42] In addition, no effect is detected on female neonate death.

5.3 Breastfeeding initiation and duration

I examine the effect of pre-birth exposure to Ramadan on two breastfeeding outcomes: breastfeeding initiation and breastfeeding duration. In the unprocessed sample, about 96% of children are breastfed regardless of the timing of breastfeeding initiation.[43] Among them, about 27%, 32%, and 59% were put to breast immediately, in the first hour, and in the first day after birth, respectively. Accordingly, I construct the following breastfeeding initiation outcomes: if ever breastfed *versus* never breastfed, if breastfeeding initiated immediately after birth *versus* never breastfed, if it initiated in the first hour after birth *versus* never breastfed, if it initiated in the first day after birth versus never breastfed, and the day number at which breastfeeding initiated.

The results, presented in Tables (E.3.1) and (E.3.2) in Appendix E.3, show no significant effect of pre-birth exposure to Ramadan on the initiation of breastfeeding among male children.[44] However,

[41] This source of uncertainty in assignment of exposure is in addition to another one, the lack of information about length of gestation.

[42] If month 9 before is the month of conception, or length of gestation is 9 months, documenting an effect of exposure to Ramadan during this month is more likely because the likelihood of observing Ramadan is greater during the month.

[43] The unprocessed sample is the sample in which only the availability of information on whether a child is ever breastfed is considered. In the regression samples, availability of exact birth dates and all of the control variables are also considered. The distribution of observations— by country, survey, religion, and sex— in the regression analyses are presented in Table (A.3), Appendix A.

[44] The effects of interest are estimations of coefficient β in Model (3) that compares exposed Muslim children to non-exposed and non-Muslim children.

some statistically significant, or close to statistically significant, negative effects are detected on female children in fixed-effect regressions when the entirety of the presumed gestation is considered (Table E.3.1, Panel B, Appendix E.3). In this case, a full exposure may decrease the likelihood of ever being breastfed by about 0.6 percentage points. Also, the likelihood of breastfeeding initiation immediately, during the first hour, and during the first day after birth may decrease by about 2.1, 2.4, and 1.1 percentage points, respectively. In addition, a full exposure may delay breastfeeding initiation by about 0.09 day. These effects however disappear when broken down into trimesters of gestation (Table E.3.2, Panel B, Appendix E.3).

To examine the effect of pre-birth exposure to Ramadan on breastfeeding duration, I use number of months of breastfeeding and whether a child is breastfed for at least 3, 4, ..., or 16 complete months as outcome variables.[45] I examine each of the outcomes under two general settings: (A) when all children, those who are currently being breastfed and those who are not, are included in the sample and (B) when only children who are not currently being breastfed are included in the sample. The first sample constitutes younger children who will probably be breastfed longer than what is reported, but it provides greater variations in the outcomes. On the other hand, the reported duration of breastfeeding in the second sample may suffer from reporting error since it mainly constitutes older children. Under each setting, I consider two cases: (1) when never breastfed children are included and (2) when they are excluded. The latter is to address the concern that never breastfed children or their mothers can be typically different from breastfed children and their mothers.

The results, estimated by the OLS and fixed-effect methods and presented in Tables (E.3.3)–(E.3.6) in Appendix E.3, show no differential effect of exposure to Ramadan on female children's breastfeeding duration. For male children also no significant negative effect in breastfeeding duration up to 12 months of age, which is the recommended breastfeeding length by the WHO, is traced. In other words, pre-birth exposure to Ramadan is not associated with greater likelihood of being breastfed for less than 3, 4, ... , or 12 months. It also does not negatively impact months of breastfeeding. However, patterns of negative effects, although small and mostly statistically insignificant, can be detected after the 12th month of age for male children. Such patterns are especially detectable in the OLS estimations, presented in Table (E.3.3) in Appendix E.3. For example, the estimated coefficients for 13, 14, 15, and 16 months of breastfeeding translate to about 0.77, 0.97, 0.85, and 0.45 percentage points decreases in the likelihood of breastfeeding, respectively, as results of pre-birth exposure to a full 30-day Ramadan.[46]

5.4 Maternal delivery and postpartum complications

In the unprocessed sample, 116,557, 144,012, 110,663, and 111,869 mothers have answered the questions about prolonged labor, excessive bleeding, uterus infection, and convulsion, respectively. Among them, about 24%, 15%, 11%, and 10% have reported the complications, respectively. In the regression samples, in which availability of exact birth dates and covariates reduces the number of observations, the ratios are preserved.[47]

Results of estimating the effect of pre-birth exposure to Ramadan on the outcomes are reported in

[45] I do not use dependent variables that are constructed based on 1 and 2 months of breastfeeding because: first, the comparison groups will considerably shrink; second, majority of children whose breastfeeding duration is 1 or 2 month(s) are currently being breastfed.

[46] Similar results are found when trimesters of gestation are examined. The negative effects on breastfeeding, which again appear after the first year of age, are more pronounced if a male child is exposed to Ramadan during trimester 3 before birth.

[47] Tables (A.2)–(A.7) in Appendix A, show the distribution of observations in the regression analyses of this section by country, survey, religion, and sex.

Table (E.4.1) in Appendix E.4.[48] A review of the results shows that pre-birth exposure to Ramadan is associated with a lower likelihood of incidence of maternal excessive bleeding, uterus infection, and convulsion during or after female births. More specifically, a full 30-day exposure to Ramadan is associated with 1.2 to 3.5 percentage points decrease in the likelihood of incidence of the complications, depending on the timing of exposure, but the strongest effect is pertinent to the trimester immediately before birth. Similar association can be seen between exposure to Ramadan and uterus infection after male births: a full 30-day exposure to Ramadan is associated with 2.1 to 2.9 percentage points decrease in the likelihood of incidence of uterus infection. However, exposure to Ramadan can increase the likelihood of incidence of excessive bleeding and convulsion after male births by about 0.8 to 1.9 percentage points if a full 30-day exposure is considered. Effect of exposure to Ramadan on prolonged labor is detected for neither male no female children.

5.5 Maternal pregnancy complications

In the unprocessed sample, 94,443, 96,504, 213,720 mothers have responded to the questions about the incidence of (1) headache, blurry vision, or abdominal pain, (2) bleeding, and (3) night blindness during pregnancy, respectively. Among them, 25%, 10%, and 9% reported their incidence, respectively. The rates of incidence in regression samples are almost identical: 27%, 9%, and 9%, respectively.[49]

Results of OLS estimations of the effect of pre-birth exposure to Ramadan on the pregnancy complications are reported in Table (E.5.1) in Appendix E.5.[50] The results shows that pre-birth exposure to Ramadan is associated with a lower likelihood of incidence of most maternal pregnancy complications. Particularly for male children, no positive association is detected: on average, exposure to a full 30-day exposure to Ramadan during the 270-day period before birth may decrease the probability of occurrence of headache, blurry vision, or abdominal pain, bleeding, and night blindness by 2.2, 0.8, 1.2 percentage points, respectively. The negative associations are more pronounced and statistically significant if exposure happened during the first and second trimesters before birth. For example, a full 30-day exposure to Ramadan during the second trimester before birth may decrease the probability of occurrence of headache, blurry vision, or abdominal pain, bleeding, and night blindness by 7.1, 2.7, 1.5 percentage points, respectively. More or less similar, but weaker and less statistically significant, effects can be detected for female children.

The results need to be interpreted carefully because (1) they potentially suffer from the erroneous

---

[48] The outcomes— indicated by $PLABOR$, $EBLEEL$, $INFECT$, and $CONVOL$— are dummy variables that take value one when the pertinent complication is reported but zero otherwise. The reported coefficients are the estimations of coefficient β in Model (3) that compares exposed Muslim to non-exposed Muslim and non-Muslim mothers. Thus, a positive coefficient implies that exposure to Ramadan during the pertinent pre-birth episode is associated with a higher likelihood of incidence of the corresponding complication. For each outcome, I estimate a linear probability model by the OLS method. Running fixed-effect regressions is not possible for these outcomes because the complications are reported only for the last birth for a mother.

[49] Tables (A.8)–(A.10) in Appendix A, show the distribution of observations in the regression analyses of this section by country, survey, religion, and sex.

[50] The outcome variables— indicated by HBA, $BLEEL$, and $NIGHTE$, respectively— are dummy variables that contain 1 if a complication is reported and 0 otherwise. The reported coefficients are estimations of coefficient β in Model (3) that compare exposed Muslim to non-exposed Muslim and non-Muslim mothers. Thus, a positive coefficient implies that exposure to Ramadan during the pertinent pre-birth episode is associated with a higher likelihood of incidence of the corresponding complication. For each outcome, a linear probability model is estimated by the OLS method. Similar to delivery and post-delivery complications, running fixed-effect regressions is not possible for these outcomes because they are reported only for a mother's most recent pregnancy.

assignment of treatment to the treated: the complications may have occurred before any exposure to Ramadan; (2) the observation are from a limited number of countries.

5.6 Discussion

The analyses of Sections (5.1)–(5.5) are conducted to find if the outcomes provide evidence on the effect of pre-birth exposure to Ramadan on length of gestation. Assessing the effect of exposure to Ramadan on the birthweight shows a possible 23 gram negative effect. The small size of the effect in addition to the fact that it is not robust to the fixed-effect examination do not necessarily point to a reduced gestation period. Further examinations show that exposure during some specific pre-birth months has almost identical and nearly statistically significant effect on birthweight regardless of the assumption on length of gestation. The latter also can be interpreted as the insignificance of the effect of exposure to Ramadan on length of gestation. The effect on the birthweight, if any, should be interpreted conservatively since self-reported birthweights— which are used in this study— may suffer from sizable measurement error (Schieve *et al.* 1999).

The evidence from the examination of neonatal mortality does not hint at the effect of exposure to Ramadan on the gestation length. More specifically, pre-birth exposure to Ramadan slightly increases the likelihood of neonatal mortality in male children in one of the specifications; however, the effect is not robust to the choice of gestation length and intra-family comparisons. Also, no effect on female neonate death is found.

Moreover, no robust effect on the breastfeeding initiation outcomes of pre-birth exposure to Ramadan is found. An extensive analysis of breastfeeding duration outcomes nonetheless reveals a pattern of weak effects on the likelihood of breastfeeding for more than 12 months. The size and late appearance of the effect cannot justify reduced gestation length, especially when compared to the findings of the literature that assesses the relationship between the gestation length and duration of breastfeeding (Donath and Amir 2008, Lutsiv *et al.* 2013). In addition, no effect on breastfeeding duration outcomes is detected in female children. The results are robust to the choice of the method of estimation, outcome, and constraint on the estimation sample.

Pre-birth exposure to Ramadan is not positively associated with greater likelihood of incidence of most maternal pregnancy, delivery, and post-delivery complications. The exceptions are convulsion at delivery and excessive bleeding after delivery in male births. In female births, finding no positive associations between pre-birth exposure to Ramadan and the complications is consistent with other findings of this paper, that exposure to Ramadan has usually no effect on female children's outcomes.

Based on the findings, I conclude that any possible effect of prenatal exposure to Ramadan on length of gestation is minor and does not imperil the validity of the assumption on length of gestation. This study however does not consider the possibility that the effect of exposure to Ramadan on length of gestation may vary by the timing of exposure.

6. Conclusion

I investigate the effect of nutritional stress *in utero* on height using exposure to Ramadan as a natural experiment and assuming a fixed gestation length. I pay special attention to the timing of exposure, which can be distorted because of the potential effect of exposure to Ramadan on length of gestation. The lack of information on length of gestation however does not allow for a direct assessment of the distortions. To approximate the effect on length of gestation, I examine the effect of exposure to Ramadan on a series of its known correlates.

The effect of exposure to Ramadan on male children's height becomes apparent at ages 3 and 4

years, while no consistent effect on female children's height is detected. The negative effect on height of exposure to Ramadan during the 270-day period before birth is between 1.0 to 4.3 mm on average. Examining the effect of exposure during three pre-birth trimesters shows that the strongest negative effects appear in the second and third trimesters before birth and amount to 7.5 mm on average. Similar pattern of effect is observed if exposure during nine pre-birth months is examined. A negative height effect can amount to an average 12.2 mm if a full exposure occurs in month 4 before birth, when growth of the long bones is at its highest rate. There is a clear pattern of effect on height when exposed and non-exposed 3- or 4-year-old Muslim boys are compared: the strongest effect appears in the further months from birth, but the effect gradually weakens approaching birth.

Pre-birth exposure to Ramadan is associated with a 23 gram decrease in birthweight in some specifications. In addition, exposure to Ramadan has no or small effect on neonatal mortality and breastfeeding outcomes, although a pattern of weak effects on the likelihood of breastfeeding male children for more than one year can be distinguished. Exposure to Ramadan also is not associated with higher risks of incidence of most maternal pregnancy and delivery complications for both male and female children. The exceptions are excessive bleeding and convulsion at delivery when a male child is born. In these cases, the risks are in 0.8 to 1.9 percentage point range. On the whole, exposure to Ramadan has minor to no effect on the correlates of length of gestation. Therefore, it may have slim, if any, effect on length of gestation and may not distort the analyses that rely on the timing of exposure.

This paper examines and reviews a wide range of health consequences of experiencing Ramadan during gestation. Since about three-fourth of Muslims undergo Ramadan *in utero*, improving nutritional environment for pregnant women may result in significant long-term health then economic improvements in Muslim communities. Advocating improvement of nutritional environment for pregnant women, completely and unequivocally exempting them from fasting— not even requiring makeup after pregnancy— by religious authorities, and assigning designated areas for pregnant women's eating during Ramadan in the workplace are some policies that can be pursued. This paper also emphasizes on the importance of information on length of gestation. Medical technological progress allows for the precise measurement of length of gestation. At the same time, inclusion of length of gestation in health cards and reporting it in surveys can provide valuable information to researchers.

References

Adeney, Kathryn L., and Michelle A. Williams, 2006," Migraine headaches and preeclampsia: an epidemiologic review," Headache: The Journal of Head and Face Pain, 46(5), 794–803.

Akresh, Richard, Sonia Bhalotra, Marinella Leone, and Una Osili, 2012," War and stature: growing up during the Nigerian civil war," American Economic Review (Papers & Proceedings), 102(3), 273–277.

Almond, Douglas, and Bhashkar Mazumder, 2011," Health capital and the prenatal environment: the effect of Ramadan observance during pregnancy," American Economic Journal: Applied Economics, 3(4), 56–85.

Almond, Douglas, Bhashkar Mazumder, and Reyn van Ewijk, 2011," Fasting during pregnancy and children's academic performance," NBER Working Paper, No. 17713.

American College of Obstetricians and Gynecologists, 1996," Technical Bulletin No. 219: Hypertension in pregnancy," International Journal of Gynecology Obstetrics, 53(2), 175–83.

American College of Obstetricians and Gynecologists, 2013," Committee Opinion No. 579: Definition of term pregnancy," Obstetrics Gynecology, 122(5), 1139–1140.

Amini, Saeid B., Patrick M. Catalano, Victor Hirsch, and Leon I. Mann, 1994," An analysis of birth weight by gestational age using a computerized perinatal data base, 1975–1992," Obstetrics and Gynecology, 83(3), 342–352.

Ananth, Cande V., and Robert W. Platt, 2004," Reexamining the effects of gestational age, fetal growth, and maternal smoking on neonatal mortality," BMC Pregnancy and Childbirth, 4(22), 1–9.

Ananth, Cande V., and David A. Savitz, 1994," Vaginal bleeding and adverse reproductive outcomes: a meta-analysis," Obstetrical & Gynecological Survey, 49(7), 445–446.

Awwad, J., I. M. Usta, J. Succar, K. M. Musallam, G. Ghazeeri, and A. H. Nassar, 2012," The effect of maternal fasting during Ramadan on preterm delivery: A prospective cohort study," BJOG: An International Journal of Obstetrics & Gynaecology, 119(11), 1379–1386.

Bais, Joke M., Martine Eskes, Maria Pel, Gouke J. Bonsel, and Otto P. Bleker, 2004," Postpartum haemorrhage in nulliparous women: incidence and risk factors in low and high risk women.

A Dutch population-based cohort study on standard (or = 500 ml) and severe (or = 1000 ml) postpartum haemorrhage," European Journal of Obstetrics, Gynecology, and Reproductive Biology, 115(2), 166–72.

Banerjee, Abhijit, Esther Duflo, Gilles Postel-Vinay, and Timothy M. Watts, 2007," Long run health impacts of income shocks: wine and phylloxera in 19th century France," NBER Working Paper, No. 12895.

Barker, D. J., 1999," Early growth and cardiovascular disease," Archives of Disease in Childhood, 80(4), 305–307.

Barker, D. J., C. Osmond, J. Golding, 1990," Height and mortality in the counties of England and Wales," Annals of Human Biology, 17(1), 1–6.

Bech, Bodil Hammer, Carsten Obel, Tine Brink Henriksen, and JÃ¸rn Olsen, 2007," Effect of reducing caffeine intake on birth weight and length of gestation: randomised controlled trial," British Medical Journal, 334(7590), 409–412.

Bhatta, Simiri R., and Remon Keriakos, 2011," Review of the recent literature on the mode of delivery for singleton vertex preterm babies," Journal of Pregnancy, Volume 2011, Article ID 186560, 5 pages.

Bloomfield, Frank H, 2011, " How Is Maternal Nutrition Related to Preterm Birth?" Annual Review of Nutrition, 31, 235–261.

Breathnach, Fionnuala, and Michael Geary, 2009," Uterine atony: definition, prevention, nonsurgical management, and uterine tamponade," Seminars In Perinatology, 33(2), 82–87.

Carslake, David, Abigail Fraser, George D. Smith, Margaret May, Tom Palmer, Jonathan Sterne, Karri Silventoinen, Per Tynelius, Debbie A. Lawlor, and Finn Rasmussen, 2013," Associations of mortality with own height using son's height as an instrumental variable," Economics and Human Biology, 11(3), 351–359.

Casas, Maribel, Sylvaine Cordier, David MartÃ-nez, Henrique Barros, Jens Bonde, Alex Burdorf, Nathalie Costet, Ana Cristina dos Santos, Asta Danileviciute, Merete EggesbÃ¸, Mariana F. Fernandez, Joelle Fevotte, Ana M. Garcia, Regina Grazuleviciene, Eva Hallner, Wojciech Hanke, Manolis Kogevinas, Inger Kull, Pernille S. Larsen, Vasiliki Melaki,Christine Monfort, Karl-Christian Nordby, Anne-Marie Nybo Andersen, Evridiki Patelarou, Kinga Polanska, Lorenzo Richiardi, Loreto S. Marina, Claudia Snijder, Adonina TardÃ³n, Manon van Eijsden, Tanja G. Vrijkotte, Daniela Zugna, Mark Nieuwenhuijsen, Martine Vrijheid, 2015," Maternal occupation during pregnancy, birth weight, and length of gestation: combined analysis of 13 European birth cohorts," Scandinavian journal of work, environment & health, 41(4), 384–396.

Chaim, Walter, Asher Bashiri, Juri Bar-david, Ilana Shoham-vardi, and Moshe Mazor, 2000," Prevalence and clinical significance of postpartum endometritis and wound infection," Infectious Diseases in Obstetrics and Gynecology, 8(2), 77–82.

Christian, Parul, Keith P. West, Subarna K. Khatry, Elizabeth Kimbrough-Pradhan, Steven C. Leclerq, Joanne Katz, Sharada R. Shrestha, Sanu M. Dali, and Alfred Sommer, 2000," Night blindness during pregnancy and subsequent mortality among women in Nepal: effects of vitamin A and -carotene supplementation," American Journal of Epidemiology, 152(6), 542–547.

Cooper, Cyrus, Avan A. Sayer, and Dennison Elaine M., 2006," The developmental environment: clinical perspectives on effects on the musculoskeletal system," in Developmental Origins of Health and Diseases, ed. Peter Gluckman and Mark Hanson, Cambridge University Press, Cambridge, UK.

Fetal growth disorders, In: Cunningham, F. Gary, editor, 2001,Williams Obstetrics, 21st ed, McGraw-Hill, New York.

Cutler, David M., Grant Miller, and Douglas M. Norton, 2007," Evidence on early-life income and late-life health from America's Dust Bowl era," Proceedings of the National Academy of Sciences, 104(33), 13244–13249.

de Freitas, Brunnella A., Luciana M. Lima, Carla F. Carlos, Silvia E. Priore, Sylvia C. Franceschini, 2016," Duration of breastfeeding in preterm infants followed at a secondary referral service," Revista Paulista de Pediatria (English Edition), Forthcoming.

Dercon, Stefan, and Catherine Porter, 2010," Live aid revisited: long-term impacts of the 1984 Ethiopian famine on children," Centre for the Study of African Economies Series, WPS/2010-39.

Dikensoy, Ebru, Ozcan Balat, Bahar Cebesoy, Ayhan Ozkur, Hulya Cicek, and Gunay Can, 2009, " The effect of Ramadan fasting on maternal serum lipids, cortisol levels and fetal development," Archives of gynecology and obstetrics, 279(2), 119–123.

Digre, Kathleen B., 2013," Headaches during pregnancy," Clinical Obstetrics and Gynecology,56(2), 317–329.

Dutta, Anita, Toni Tonkin, and Wolf Gelman, 2006," Postpartum convulsions - a diagnostic enigma," Journal of the Royal Society of Medicine, 99(4), 202–204.

Donahue, Sara, Ken P. Kleinman, Matthew W. Gillman, and Emily Oken, 2010," Trends in birth weight and gestational length among singleton term births in the United States: 1990–2005," Obstetrics and Gynecology, 115(2 Pt 1), 357–364.

Donath, S. M., and L. H. Amir, 2008," Effect of gestation on initiation and duration of breastfeeding," Archives of Disease in Childhood – Fetal and Neonatal Edition, 93(6), F448–F450

Espy, Kimberly A., and Theresa E. Senn, 2003," Incidence and correlates of breast milk feeding in hospitalized preterm infants," Social Science & Medicine, 57(8), 1421–1428

Eriksson, Johan G., 2006," Patterns of growth: relevance of developmental origins of health and diseases," in Developmental Origins of Health and Diseases, ed. Peter Gluckman and Mark Hanson, Cambridge University Press, Cambridge, UK.

Factor-Litvak, Pam, Joseph H. Graziano, Jennie K. Kline, Dusan Popvac, Ali Mehmeti, Gemail Ahmedi, Patrick Shrout, Mary Murphy, Emine Gashi, Radmila Haxhiu, Ljubica Rajovic, Dragoslav U. Nenezic, and Zean A. Stein, 1991," A prospective study of birthweight and length of gestation in a population surrounding a lead smelter in Kosovo, Yugoslavia," International journal of epidemiology, 20(3), 722–728.

Fogel, Robert W., 1994," Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy," The American Economic Review, 84(3), 369–395.

Fukuda Misao, Kyomi Fukuda, Takashi Shimizu, Henrik Moller, 1998,“ Decline in sex ratio at birth after Kobe earthquake,” Human Reproduction, 13(8), 2321–2322.

Gluckman, P. D., W. Cutfield, J. E. Harding, D. Milner, E. Jensen, S. Woodhall, B. Gallaher, M. Bauer, and B. H. Breier, 1996,“ Metabolic consequences of intrauterine growth retardation,” Acta Paediatrica, 85(417), 3–6.

Gluckman, Peter, and Mark Hanson, 2005,The Fetal Matrix: Evolution, Development and Disease, Cambridge University Press, Cambridge.

Goldenberg, Robert L., and William W. Andrews, 1996, “ Intrauterine infection and why preterm prevention programs have failed, ” American Journal of Public Health, 86(6), 781–783.

Gualtieri, Thomas and Robert E. Hicks, 1985,“ An immunoreactive theory of selective male affliction,” Behavioral and Brain Sciences, 8(3), 427–441.

Hanson, Dorthe, Henrik Moller, and Jorn Olsen, 1999,“ Severe peri-conceptional life events and the sex ratio in offspring: follow up study based on five national registers,” British Medical Journal, 319(7209), 548–549.

Jamilian M., D. Hekmatpou, H. R. Jamilian, S. H. Ardalan and M. Shamsi , 2015,“ The effect of Ramadan fasting on outcome of pregnancy,” Middle-East Journal of Scientific Research, 23(7), 1270–1275.

Jousilahti, Pekka, Jaakko Tuomilehto, Erkki Vartiainen, Johan Eriksson, and Pekka Puska, 2000,“ Relation of adult height to cause-specific and total mortality: a prospective follow-up study of 31,199 middle-aged men and women in Finland,” American Journal of Epidemiology, 151(11), 1112–1120.

Karateke, Atilla, Mustafa Kaplanoglu, Fazil Avci, Raziye Keskin Kurt, and Ali Baloglu, 2015,“ The effect of Ramadan fasting on fetal development,” Pakistan Journal of Medical Sciences Quarterly, 31(6), 1295–1299.

Kapoor, Amita, Elizabeth Dunn, Alice Kostaki, Marcus H. Andrews, and Stephen G. Matthews, 2006,“ Fetal programming of hypothalamo-pituitary-adrenal function: Prenatal stress and glucocorticoids,” Journal of Physiology, 572(1), 31–44.

Karimi, Seyed M., 2016,“ The effect of exposure to Ramadan in utero on children’s height and its potential implications for long-term health,” Working Paper, University of Washington Tacoma.

Kavehmanesh Zohreh, and Hassan Abolghasemi, 2004,“ Maternal Ramadan fasting and neonatal health,” Journal of Perinatology, 24(2), 748–750.

Kennedy, Anne, 2000,“ Assessment of acute abdominal pain in the pregnant patient,” Seminars in Ultrasound CT and MR, 21(1), 64–77.

Koopmans, Corine M., Denise Bijlenga, Henk Groen, Sylvia M. Vijgen, Jan G. Aarnoudse, Dick J. Bekedam, Paul P. van den Berg, Karin de Boer, Jan M. Burggraaff, Kitty W. Bloemenkamp,

Addy P. Drogtrop, Arie Franx, Christianne J. De Groot, Anjoke J. Huisjes, Anneke Kwee, Aren J. van Loon, Annemiek Lub, Dimitri N. Papatsonis, Joris A. van der Post, Frans J. Roumen, Hubertina C. Scheepers, Christine Willekes, Ben W. Mol, and Maria G. van Pampus, 2009," Induction of labour versus expectant monitoring for gestational hypertension or mild pre-eclampsia after 36 weeks' gestation (HYPITAT): A multicentre, open-label randomised controlled trial," Lancet, 374(9694), 979–988.

Kraemer, Sebastian, 2000," The fragile male," British Medical Journal, 321(7276), 1609–1612.

Khurana, Jasvir S., 2009, Bone Pathology, New York, NY: Humana Press.

Kusin, A. Jane, Sari Kardjati, Joop M. Houtkooper, and U. H. Renqvist, 1992," Energy supplementation during pregnancy and postnatal growth," Lancet, 340(8820), 623–626.

Lavoie Mark E., Philippe Robaey, Stauder, Johannes E., Jacqueline Glorieux, and Francine Lefebvre, 1998," Extreme prematurity in healthy 5-year-old children: a re-analysis of sex effects on event-related brain activity," Psychophysiology, 22, 35(6), 679–689.

Lawn, Joy E., Simon Cousens, and Jelka Zupan, 2005," 4 million neonatal deaths: When? Where? Why?" Lancet, 365(9462), 891–900.

Lawn, Joy E., Kate Kerber, Christabel Enweronu-Laryea, and Simon Cousens, 2010," 3.6 million neonatal deathsâ€"what is progressing and what is not?" Seminars in Perinatology, 34(6), 371–386.

Loke, Y. W., 1978, Immunology and Immunopathology of Human Fetal-Maternal Interaction, Elsevier/North-Holland.

Lowe, Nancy K., 2007," A review of factors associated with dystocia and cesarean section in nulliparous women" Journal of Midwifery & Womenâ€™s Health, 52(3), 216–228.

Lutsiv, Olha, Lucia Giglia, Eleanor Pullenayegum, Gary Foster, Claudio Vera, Barbara Chapman, Christoph Fusch, and Sarah D. McDonald, 2013," A population-based cohort study of breastfeeding according to gestational age at term delivery," Journal of Pediatrics, 163(5), 1283–1288.

Lyster W. R., 1974," Altered sex ratio after London smog of 1952 and the Brisbane flood of 1965," BJOG: An International Journal of Obstetrics & Gynaecology, 81(8), 626–631.

Maccini, Sharon, and Dean Yang, 2009, " Under the weather: health, schooling, and economic consequences of early-life rainfall," American Economic Review, 99(3), 1006–1026.

Majid, Muhammad F., 2013," The persistent effects of in utero nutrition shocks over the life cycle: evidence from Ramadan fasting in Indonesia," Working Paper, University of Pennsylvania.

Marozio, Luca, Marta Enrietti, Elisa Picardo, Chiara Benedetto, Fabio Facchinetti, Isabella Neri, Gianni Allais, Rossella E. Nappi, and Rossella E. Nappi, 2012," Headache and adverse pregnancy outcomes: a prospective study," European Journal of Obstetrics Gynecology and Reproductive Biology, 161(2), 140–143.

Metzger, Boyd E., Veronica Ravnikar, Rita A. Vileisis, and Norbert Freinkel, 1982, " 'accelerated starvationâ€™ and the skipped breakfast in late normal pregnancy," The Lancet, 1(8272), 588–592.

Mirghani, Hisham M., and Omer A. Hamud, 2006," The effect of maternal diet restriction on pregnancy outcome," American Journal of Perinatology, 23(1), 21–24.

Mocan, Naci, Christian Raschke, and Bulent Unel, 2015," The impact of mothersâ€™ earnings on health inputs and infant health" Economics and Human Biology, 19 (December), 204–223.

Moldenhauer, Julie S., 2016," Puerperal Endometritis" in Merck Manuals, Professional Version.

Nair, Usha, 2005," Acute abdomen and abdominal pain in pregnancy," Current Obstetrics and Gynaecology, 15(6), 359–367.

Nicholson, W., M. Croughan-Minihane, S. Posner, A. Washington, and S. Kilpatrick, 2001," Preterm delivery in patients admitted with preterm labor: a prediction study," Journal of Maternal-fetal Medicine, 10(2), 102–106.

Nystedt, Astrid, and Ingegerd Hildingsson, 2014," Diverse definitions of prolonged labour and its consequences with sometimes subsequent inappropriate treatment," BMC Pregnancy and Childbirth, 14(1), 233–233.

Olsen, Margaret A, Anne M. Butler, Denise M. Willers, Gilad A. Gross, Preetishma Devkota, and Victoria J. Fraser, 2009," Risk factors for endometritis after low transverse cesarean delivery," Infection Control and Hospital Epidemiology, 31(1), 69–77.

Rosales, Maria F., 2013," Impact of early-life shocks on human capital formation: evidence from El Nino floods in Ecuador," Working Paper, University of California Irvine.

Ross, Michael H., and Wojciech Pawlina, 2010, Histology: A Text and Atlas - With Correlated Cell and Molecular Biology, Philadelphia: Lippincott Williams & Wilkins.

Roseboom, T. J., J. H. P. van der Meulen, C. Osmond, David J. Barker, A. C. J. Ravelli, J. M. Schroeder Tanka, G. A. van Montfrans, R. P. J. Michels, and O. P. Bleker, 2000," Coronary heart disease after prenatal exposure to the Dutch famine 1944-45," Heart, 84(6), 595–598.

Salleh, H., 2001," Ramadan fasting among pregnant women in Muar district, Malaysia and its association to health outcomes," Malaysian journal of reproductive health, 7(1), 69–83.

Schieve, Laura A., Geraldine S. Perry, Mary E. Cogswell, Kelley S. Scanlon, Deborah Rosenberg, Suzan Carmichael, and Cynthia Ferre, 1999, " Validity of self-reported pregnancy delivery weight: an analysis of the 1988 National Maternal and Infant Health Survey," American Journal of Epidemiology, 150(9), 947–956.

Sharami, S. Hajar, Roya Faraji-Darkhaneh, Ziba Zahiri, Forozan Milani, Maryam Asgharnia, Maryam Shakiba, and Zirak Didar, 2013," The relationship between vaginal bleeding in the first and second trimester of pregnancy and preterm labor," Iranian Journal of Reproductive Medicine, 11(5), 385–390.

Sheth, Bhavna P., and William F. Mieler, W., 2001," Ocular complications of pregnancy," Current Opinion in Ophthalmology, 12(6), 455–463.

Sibai, Baha M., 2011," Management of late preterm and early-term pregnancies complicated by mild gestational hypertension/pre-eclampsia," Seminars In Perinatology, 35(5), 292–296.

Stotland, Naomi E., Linda M. Hopkins, and Aaron B. Caughey, 2004," Gestational weight gain, macrosomia, and risk of cesarean birth in nondiabetic nulliparas," Obstetrics and Gynecology, 104(4), 671–677.

Sweeting, Arianne N, Glynis P. Ross, Jon Hyett, Lynda Molyneaux, Maria Constantino, Anna J. Harding, and Janca Wong, 2016," Gestational diabetes mellitus in early pregnancy: evidence for poor pregnancy outcomes despite treatment" Diabetes Care, 39(1), 75–81.

Schultz-Nielsen, Marie Louise, Erdal Tekin, and Jane Greve, 2016," Labor market effects of intrauterine exposure to nutritional deficiency: Evidence from administrative data on Muslim immigrants in Denmark" Economics and Human Biology, 21(May), 196–209.

Tielsch, James, Lakshmi Rahmathullah, Joanne Katz, R. Thulasiraj, Christian Coles, S. Sheeladevi, and Kartik Prakash, 2008," Maternal night blindness during pregnancy is associated with low birthweight, morbidity, and poor growth in South India1,2," The Journal of Nutrition, 138(4), 787–92.

van Ewijk, Reyn, 2011," Long-term health effects on the next generation of Ramadan fasting during pregnancy," Journal of Health Economics, 30(6), 1246–1260.

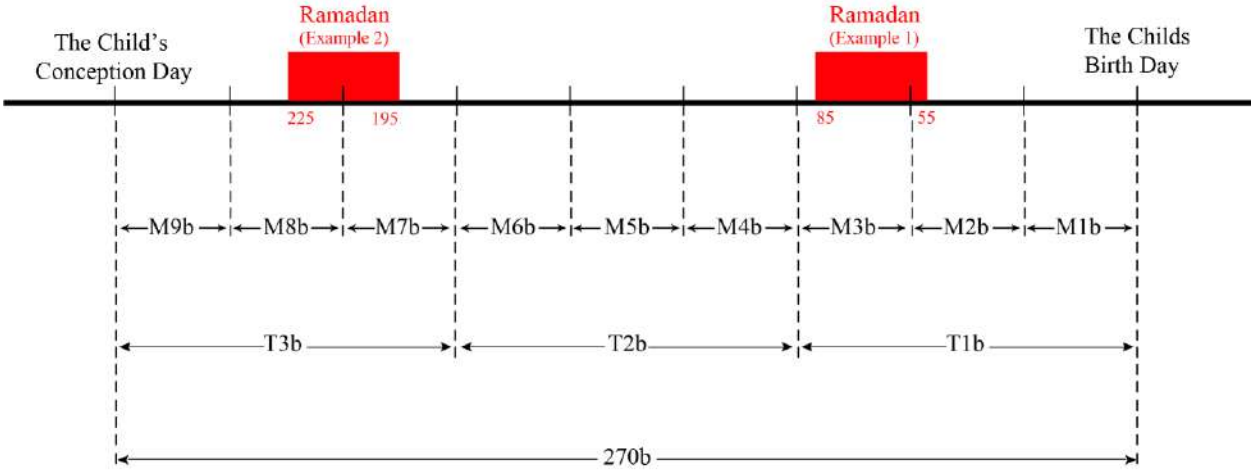
Waaler, Hans T., 1984," Height, weight, and mortality: the Norwegian experience," Acta Medica Scandinavica, 215(S679), 1–56.

Yang, Juan, Katherine E. Hartmann, David A. Savitz, Amy H. Herring, Nancy Dole, Andrew F. Olshan, and John M. Thorp, 2004," Vaginal bleeding during pregnancy and preterm birth," American Journal of Epidemiology, 160(2), 118–125.

Ziaee, Vahid, Farzad Bateni, Zarintaj Kihanidoost, Masoud Younesian, Mohammad-Bagher Akhavirad, and Sedigheh Hantoushzadeh, 2010," The Effect of Ramadan Fasting on Outcome of Pregnancy," Iranian Journal of Pediatrics, 20(2), 181–186.

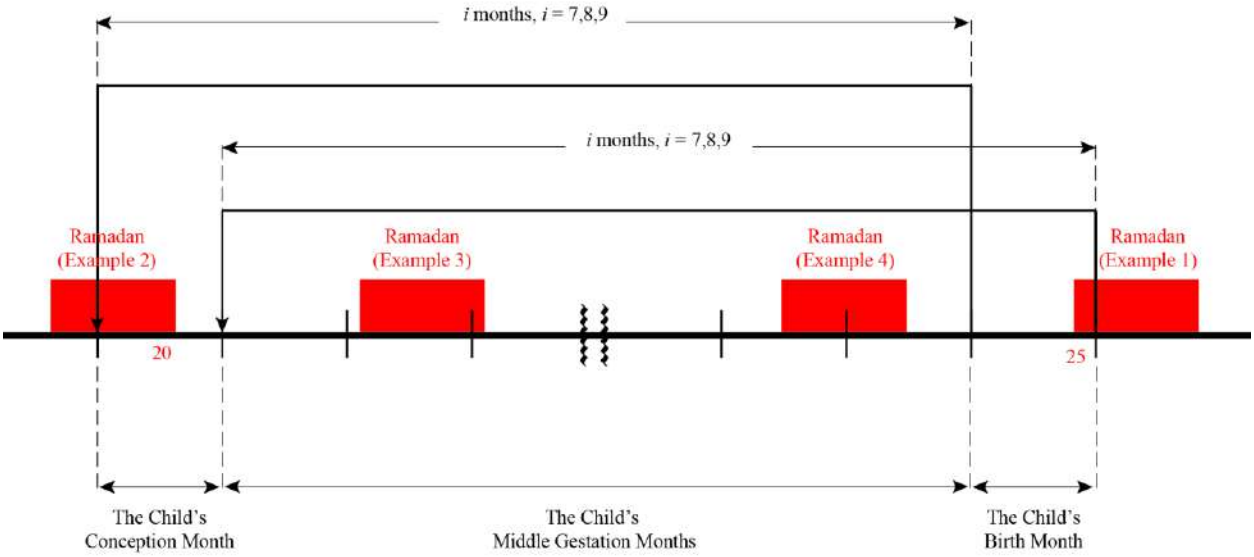
Zorn, Branko, Veselin Suser, Janez Stare, and Helena Meden-Vrtovec, 2002," Decline in sex ratio at birth after 10-day war in Slovenia," Human Reproduction, 17(12), 3173–3177.

Figure 1: Finding exposure to Ramadan during the pre-birth episodes when a child's exact birth date is available



Notes: The figure shows how exposure to Ramadan during the specified episodes of gestation is determined when the child's exact birth date is available. It is assumed that the child's gestation lasts for 270 days. Using the child's exact birth date, the period is divided into three 90-day episodes (trimesters) and nine 30-day episodes (months). More specifically, 270b, T1b, T2b, T3b, M1b, M2b, ... , and M9b tag the 270-day period, trimester 1, trimester 2, trimester 3, month 1, month 2, ... , and month 9 before birth, respectively. If Ramadan starts from day 85 and ends on day 55 before birth (Example 1), then the child was exposed to Ramadan during trimester 1 before birth: 5 days of exposure in the trimester occurred in month 2 before birth, while the next 25 days occurred in month 3 before birth. Although there is not more than one Ramadan in each 355-day period, I have shown another Ramadan that starts from day 225 and ends on day 195 before birth (Example 2). In the latter example, the child was exposed to Ramadan during trimester 3 before birth: half of the exposure occurred in month 7 before birth, while the other half occurred in month 8 before birth. Number of days of exposure to Ramadan in an episode and the number of daylight hours in the corresponding days are then used to determine the total hours of exposure to Ramadan in the episode.

Figure 2: Finding exposure to Ramadan during the pre-birth episodes when a child's exact birth date is not available



Notes: The figure shows how exposure to Ramadan during the episodes of gestation (namely, birth month, conception month, and middle-gestation months) is determined when the child's exact birth date is not available. The unavailability of the child's exact birth date makes exposure assignment more uncertain because the child could have been born in any day from the first to the last day of the child's reported birth month. Therefore, a birth month and a conception month, instead of a birth day and a conception day, are specified, depending on the assumption on length of gestation. Three scenarios are considered for gestation length: 7, 8, and 9 months. The exposure assignment can be shown with examples. If a Ramadan starts from day 25 of the child's birth month (Example 1) and the child was born in day 15 of the month, then 5 days of exposure will be assigned to the child's birth month; whereas the child is in fact not exposed to Ramadan before birth. If a Ramadan starts before the child's presumed conception month and ends in day 20 of the month (Example 2), then 20 days of exposure will be assigned to the child's conception month; whereas the actual exposure during the conception month is for 5 days if the conception took place exactly 270 days before birth. If a Ramadan starts after the presumed conception month or finishes before the presumed birth month (Examples 3 and 4), then it is more likely that exposure is assigned correctly.

Figure 3A: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a male child's height (in millimeters) at age 3 years when exposed Muslims are compared to non-exposed Muslims

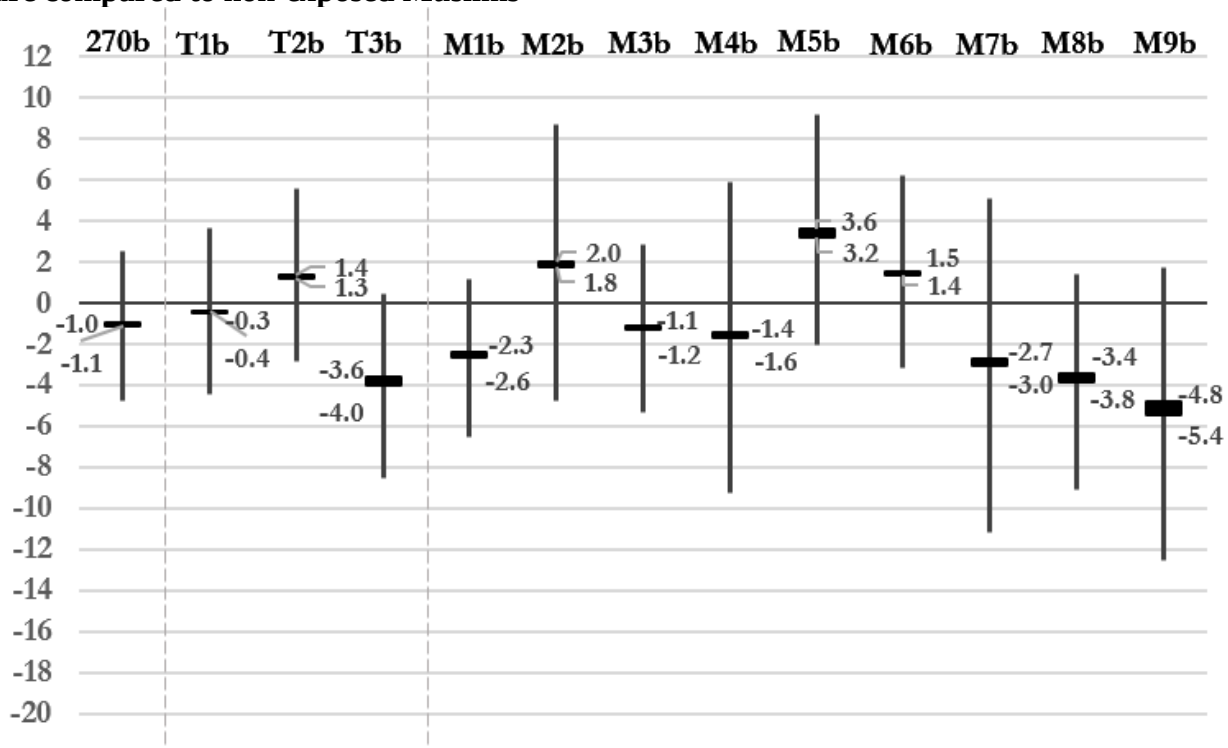
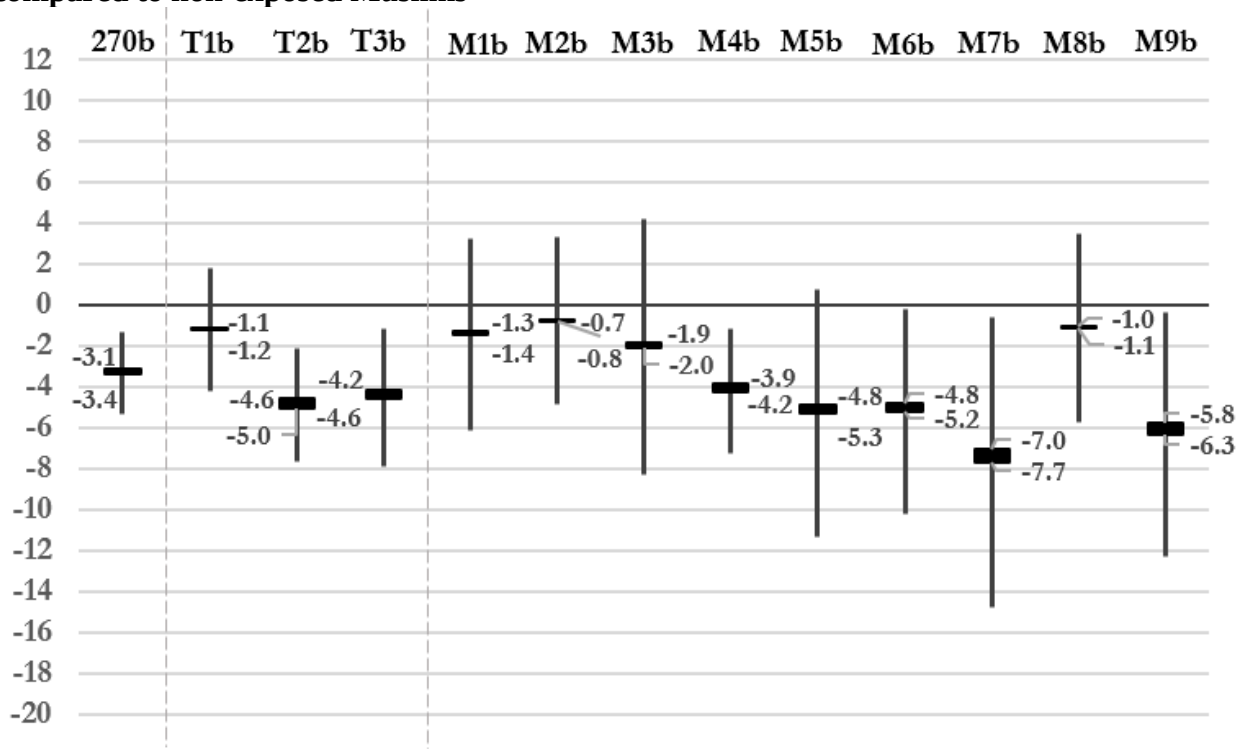


Figure 3B: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a male child's height (in millimeters) at age 4 years when exposed Muslims are compared to non-exposed Muslims



Notes: The figures present the ranges of the effect on height of a full-30 day exposures to Ramadan at different pre-birth episodes—specified at the top of the figures as 270b, T1b, T2b, T3b, M1b, M2b, ... , and M9b that indicate the 270-day period, trimester 1, trimester 2, trimester 3, month 1, month 2, ... , and month 9 before birth, respectively—when exposed male Muslim children at ages 3 and 4 are compared to non-exposed male Muslim children at the same ages. Each range is shown by a solid rectangle for which the 95% confidence interval is shown by vertical lines above and below. To find the range of the effect for an episode, first the corresponding estimated coefficient—inserted in column "Muslim" in Tables (C.1)--(C.4) in Appendix C—is multiplied by 360 (=12\times30) because an exposed child in the sample experienced Ramadan days that were about 12 hours long on average. The resulted number is the effect of a full 30-day exposure to Ramadan during the episode on a child's height-for-age Z-score. The latter number, multiplied by standard deviations of male children's height at the first and last days of the age year of interest in the reference population, gives the effect in millimeters.

Figure 4A: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a male child's height (in millimeters) at age 3 years when exposed Muslims are compared to non-exposed Muslims and non-Muslims

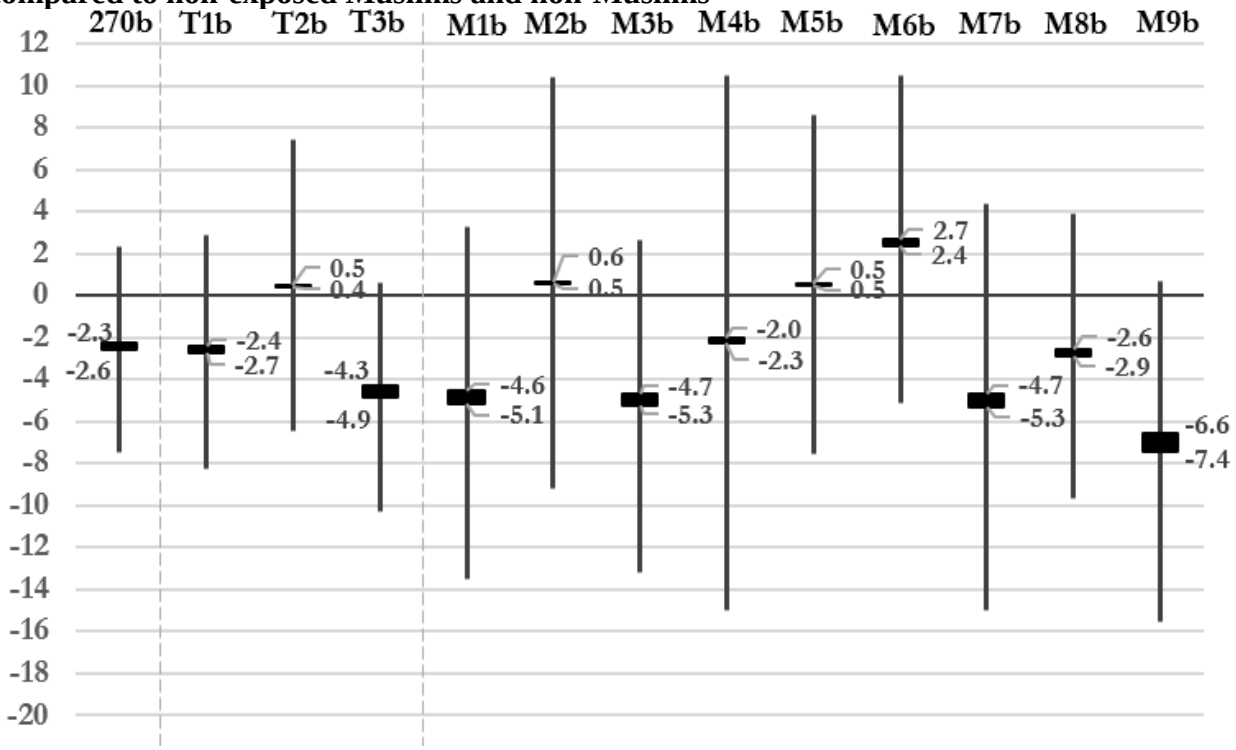
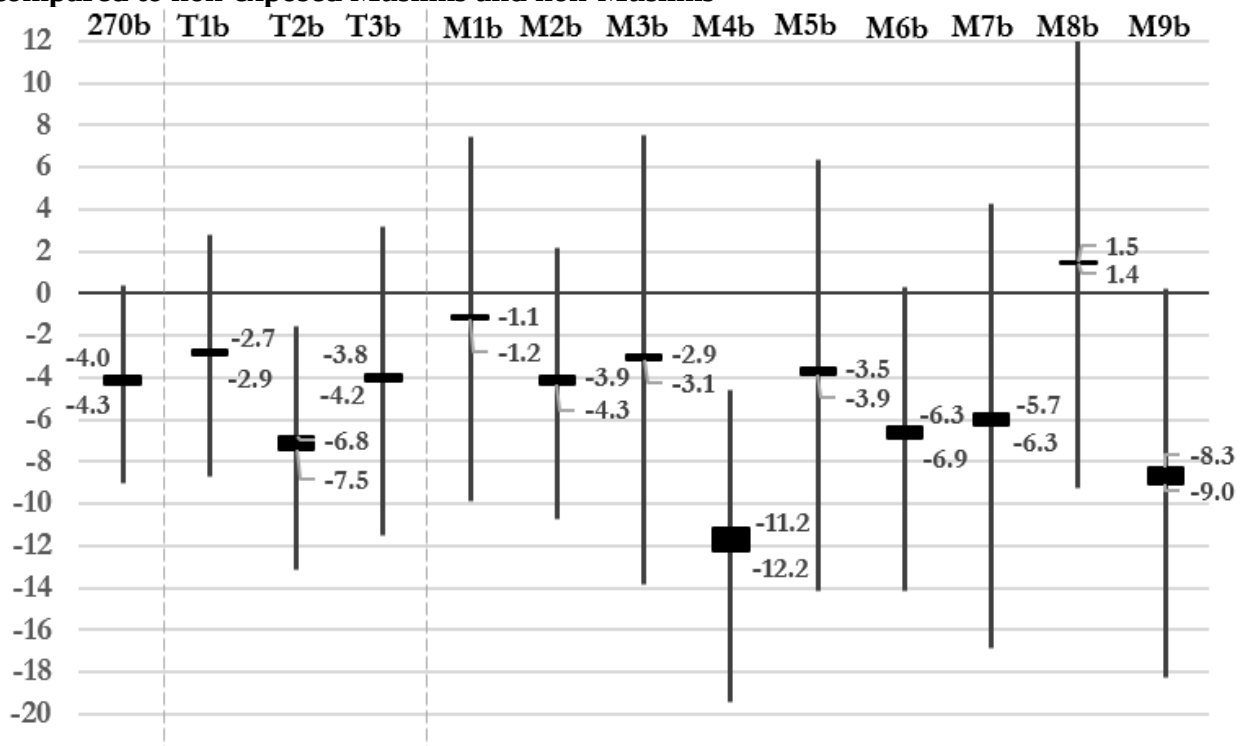


Figure 4B: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a male child's height (in millimeters) at age 4 years when exposed Muslims are compared to non-exposed Muslims and non-Muslims



Notes: The figures present the ranges of the effect on height of a full-30 day exposures to Ramadan at different pre-birth episodes—specified at the top of the figures as 270b, T1b, T2b, T3b, M1b, M2b, ... , and M9b that indicate the 270-day period, trimester 1, trimester 2, trimester 3, month 1, month 2, ... , and month 9 before birth, respectively—when exposed male Muslim children at ages 3 and 4 are compared to their non-exposed counterparts among Muslims and non-Muslims. Each range is shown by a solid rectangle for which the 95% confidence interval is shown by vertical lines above and below. To find the range of the effect for an episode, first the corresponding estimated coefficient—inserted in column "All" in Tables (C.1)--(C.4) in Appendix C—is multiplied by 360 (=12\times30) because an exposed child in the sample experienced Ramadan days that were about 12 hours long on average. The resulted number is the effect of a full 30-day exposure to Ramadan during the episode on a child's height-for-age Z-score. The latter number, multiplied by standard deviations of male children's height at the first and last days of the age year of interest in the reference population, gives the effect in millimeters.

Figure 5A: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a male child's birthweight (in grams) when exposed Muslims are compared to non-exposed Muslims and non-Muslims

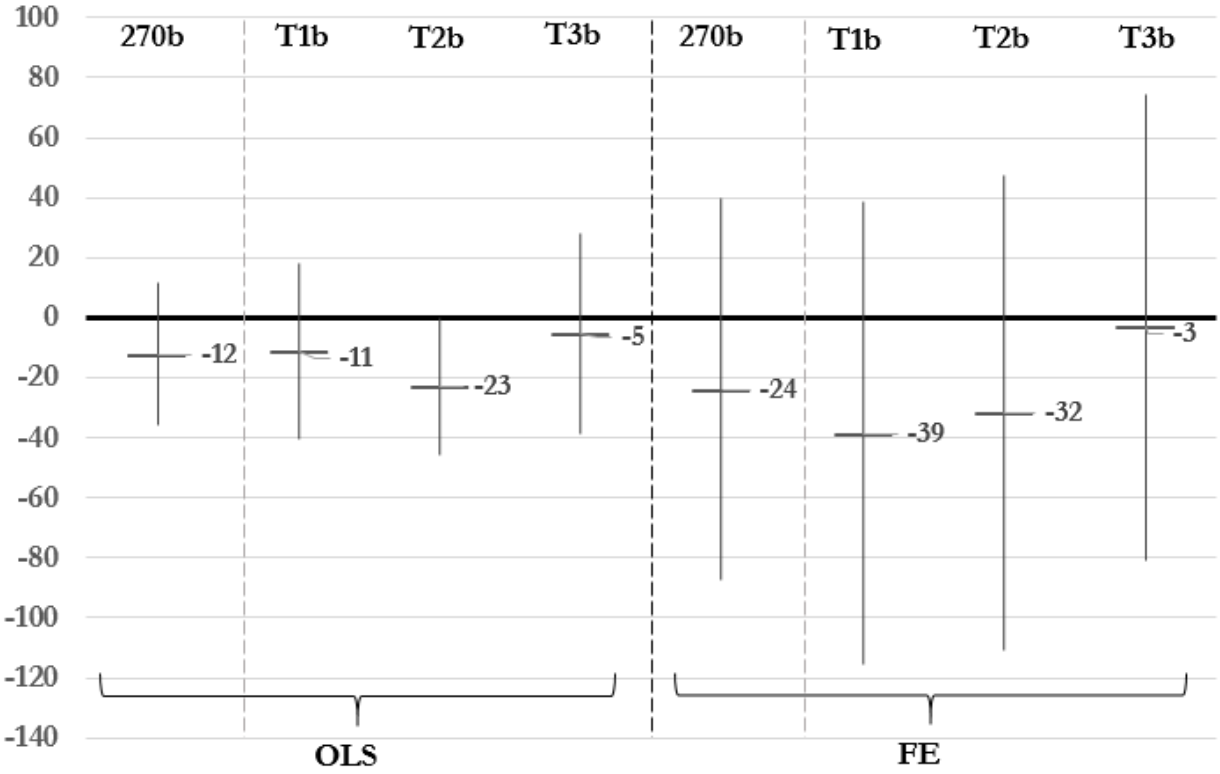
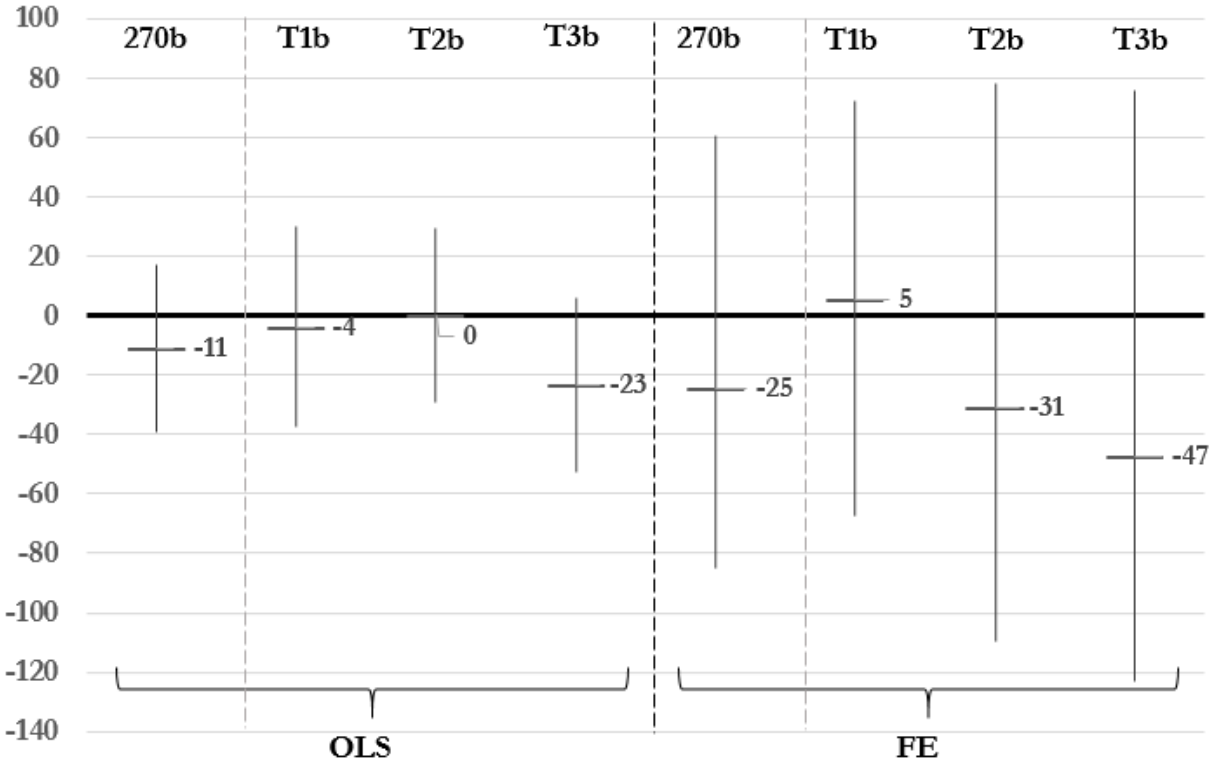


Figure 5B: The effect of a full 30-day exposure to Ramadan during different pre-birth episodes on a female child's birthweight (in grams) when exposed Muslims are compared to non-exposed Muslims and non-Muslims



Notes: The figures present the average effect on birthweight of a full-30 day exposure to Ramadan at different pre-birth episodes—specified at the top of the figures as 270b, T1b, T2b, and T3b that indicate the 270-day period and trimesters 1 to 3 before birth—when exposed male Muslim children are compared to their non-exposed Muslims and non-Muslims. The average effects are shown by horizontal lines for which the 95% confidence intervals are shown by vertical lines above and below. To find the average effects and the confidence intervals, the corresponding estimated coefficients—inserted in column "All" in Table (E.1.1) in Appendix E—are multiplied by 360 (=12\times30) since an exposed child in the sample experienced Ramadan days that were about 12 hours long on average.

Table 1: Comparing characteristics of children whose exact birth date is not reported to those of children whose exact birth date is reported

	Children whose Exact Birth Date Is not Reported	Children whose Exact Birth Date Is Reported
% with Illiterate Mother	64	43
% with Mother Completed Secondary or Higher Education	4	13
% with Illiterate Father	53	34
% with Father Completed Secondary or Higher Education	9	20
% Living Rural Areas	75	66
% of Muslims	54	50
% Who Are in a Poor Household	48	41
Average Height at Age 4 (cm)	96.7	98.7
Average Height at Age 3 (cm)	89.2	91.7
Average Height at Age 2 (cm)	81.8	84.0
Average Height at Age 1 (cm)	74.0	75.7
Average Height at Age 0 (cm)	63.3	63.4
Median Height at Age 4 (cm)	97.1	99.0
Median Height at Age 3 (cm)	89.2	92.0
Median Height at Age 2 (cm)	81.7	84.1
Median Height at Age 1 (cm)	74.0	75.4
Median Height at Age 0 (cm)	63.7	64.1
Total number observations	335,451	565,360

Notes: Each of the numbers is calculated for the corresponding subgroup of children, specified in the top row. A parent's education level is categorized in one of the followings in the data: no education (or illiterate), incomplete primary, complete primary, incomplete secondary, complete secondary, and higher. A poor household is a household whose wealth score is in lowest wealth quintile. A household's wealth score is the principle component vector of six variables: source of drinking water, type of toilet, main material of the floor, access to electricity, ownership of radio, and TV ownership.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table 2: Surveying years and number of children by country, religion and sex in the sample used in height analyses

	Country	Survey Years	Muslims		Non-Muslims		% in
			Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	420	445	87	81	0.3
2	Azerbaijan	2006	962	831	2	3	0.6
3	Bangladesh	1996-97 , 1999-2000 2004 , 2007 , 2011	9,580	9,137	1,036	980	6.7
4	Benin	1996 , 2006 , 2011-2012	975	937	4,362	4,432	3.5
5	Burkina Faso	1998-99 , 2003 , 2010	3,005	2,899	2,031	2,013	3.2
6	Burundi	2010-2011	46	42	1,171	1,108	0.8
7	Cameroon	1998 , 2004 , 2011	614	586	2,205	2,249	1.8
8	Central Afr. Rep.	1994-95	87	94	776	753	0.6
9	Chad	1996-97 , 2004	1,596	1,716	1,174	1,110	1.8
10	Comoros	1996 , 2012	963	953	3	6	0.6
11	Egypt	1995-96 , 2005 , 2008 , 2014	18,732	17,761	848	741	12.3
12	Ethiopia	1992 , 1997 , 2003	2,704	2,485	4,380	4,248	4.5
13	Gabon	2000 , 2012	151	120	1,657	1,655	1.2
14	Ghana	1998-99 , 2003 , 2008 , 2014	513	443	2,515	2,438	1.9
15	Guinea	1999 , 2005 , 2012	1,974	1,835	247	208	1.4
16	India	1998-99 , 2005-06	2,688	2,484	17,716	15,726	12.5
17	Ivory Coast	2011-12	267	262	253	272	0.3
18	Jordan	1997 , 2012	5,629	5,275	36	49	3.6
19	Kazakhstan	1995	229	257	81	94	0.2
20	Kenya	1998 , 2003 , 2008-09	603	511	3,793	3,808	2.8
21	Kyrgyzstan	1997	426	407	38	24	0.3
22	Liberia	2006-07 , 2013	316	250	2,042	1,887	1.5
23	Malawi	2000 , 2004-05 , 2010	1,180	1,217	6,895	6,960	5.3
24	Maldives	2009	476	513	0	0	0.3
25	Mali	1995-96 , 2001 , 2006 2012-2013	8,297	8,143	705	700	5.8
26	Morocco	2003-04	2,286	2,213	0	0	1.5
27	Mozambique	1997 , 2003-04 , 2011	955	1,010	4,868	4,940	3.8
28	Niger	1998 , 2006 , 2012	2,583	2,402	8	14	1.6
29	Nigeria	1999 , 2003 , 2008 , 2013	7,883	8,022	6,267	6,023	9.1
30	Pakistan	2012-13	924	911	0	0	0.6
31	Senegal	2005 , 2010-11	1,510	1,361	47	56	1.0
32	Sierra Leone	2008 , 2013	1,565	1,646	365	377	1.3
33	Tanzania	1996 , 2004-05	1,783	1,713	2,889	2,860	3.0
34	Togo	1998 , 2013-14	418	397	1,993	2,031	1.6
35	Turkey	1998	1,034	860	3	5	0.6
36	Uganda	2000-01 , 2006 , 2011	404	390	2,618	2,636	2.0
37	Uzbekistan	1996	486	464	11	14	0.3
	Total	83 surveys	84,264	80,992	73,122	70,501	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table 3: Summary statistics of children's and their parents' characteristics and children's height-for-age Z-score by religion, intensity of exposure, and sex

	Muslims			Non-Muslims		
	Not Exposed	Partially Exposed	Fully Exposed	Not Exposed	Partially Exposed	Fully Exposed
Panel A: Parent's and Household's Characteristics						
Birth Order	3.41	3.39	3.42	3.37	3.39	3.39
	(2.34)	(2.34)	(2.35)	(2.27)	(2.29)	(2.29)
Mother's Education (Years)	4.42	4.35	4.32	4.54	4.55	4.52
	(5.14)	(5.07)	(5.12)	(4.50)	(4.52)	(4.48)
Father's Education (Years)	5.40	5.28	5.29	6.28	6.29	6.26
	(5.54)	(5.50)	(5.55)	(4.89)	(4.87)	(4.83)
Mother's Age at Birth	26.66	26.56	26.60	26.59	26.65	26.56
	(6.46)	(6.42)	(6.47)	(6.38)	(6.43)	(6.38)
Father's Age at Birth	35.52	35.52	35.51	33.59	33.63	33.67
	(9.69)	(9.82)	(9.84)	(9.40)	(9.45)	(9.46)
Mother's Height (cm)	158	158	158	156	156	157
	(6.80)	(6.77)	(6.75)	(6.82)	(6.87)	(6.84)
Living in Rural Areas (%)	64	64	65	73	73	73
Number of Observations	25,805	27,179	112,272	22,632	23,835	97,156
Panel B: Height-for-Age Z-scores by Age						
	Boys:					
Height-for-Age Z-score at Age 0	-0.68	-0.67	-0.67	-0.77	-0.80	-0.84
	(1.99)	(1.98)	(2.00)	(1.86)	(1.88)	(1.92)
Height-for-Age Z-score at Age 1	-1.65	-1.62	-1.60	-1.79	-1.84	-1.94
	(1.92)	(1.94)	(1.93)	(1.80)	(1.82)	(1.76)
Height-for-Age Z-score at Age 2	-1.71	-1.75	-1.75	-1.94	-2.02	-2.02
	(1.83)	(1.90)	(1.85)	(1.63)	(1.65)	(1.65)
Height-for-Age Z-score at Age 3	-1.48	-1.50	-1.60	-1.85	-1.83	-1.90
	(1.70)	(1.72)	(1.76)	(1.52)	(1.54)	(1.59)
Height-for-Age Z-score at Age 4	-1.33	-1.38	-1.46	-1.66	-1.68	-1.74
	(1.64)	(1.61)	(1.63)	(1.42)	(1.50)	(1.50)
Number of Observations	13,227	13,706	57,331	11,617	12,169	49,336
	Girls:					
Height-for-Age Z-score at Age 0	-0.57	-0.50	-0.46	-0.58	-0.59	-0.64
	(1.93)	(1.85)	(1.89)	(1.86)	(1.78)	(1.82)
Height-for-Age Z-score at Age 1	-1.42	-1.39	-1.35	-1.57	-1.59	-1.70
	(1.93)	(1.89)	(1.92)	(1.74)	(1.69)	(1.70)
Height-for-Age Z-score at Age 2	-1.63	-1.66	-1.60	-1.77	-1.80	-1.89
	(1.83)	(1.75)	(1.86)	(1.55)	(1.62)	(1.61)
Height-for-Age Z-score at Age 3	-1.54	-1.40	-1.58	-1.72	-1.76	-1.84
	(1.70)	(1.77)	(1.74)	(1.53)	(1.50)	(1.59)
Height-for-Age Z-score at Age 4	-1.38	-1.33	-1.43	-1.71	-1.72	-1.74
	(1.67)	(1.65)	(1.61)	(1.45)	(1.44)	(1.47)
Number of Observations	12,578	13,473	54,941	11,015	11,666	47,820

Notes: A partially exposed child is a child who was exposed to Ramadan for 1 to 29 days during the 270-day period before birth, but a fully exposed child is exposed to a full 30-day Ramadan during the period. Standard deviations are in parentheses.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Appendix A: Distribution of observations in the analyses of the correlates of length of gestation

Table A.1: Distribution of observations in the analyses of birthweight by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	611	616	126	116	0.9
2	Azerbaijan	2006	805	665	2	2	0.9
3	Bangladesh	–	0	0	0	0	0.0
4	Benin	1996 , 2006 , 2011-2012	963	873	4,978	4,927	7.5
5	Burkina Faso	1998-99 , 2003 , 2010	2,198	2,071	1,341	1,240	4.4
6	Burundi	2010-2011	43	33	882	839	1.1
7	Cameroon	1998 , 2004 , 2011	294	314	1,878	1,837	2.8
8	Central Afr. Rep.	1994-95	61	50	401	387	0.6
9	Chad	1996-97 , 2004	345	353	282	242	0.8
10	Comoros	1996 , 2012	874	929	5	5	1.2
11	Egypt	1995-96 , 2005 , 2008 , 2014	8,308	7,574	406	328	10.6
12	Ethiopia	1992 , 1997 , 2003	219	205	520	479	0.9
13	Gabon	2000 , 2012	148	121	1,489	1,474	2.1
14	Ghana	1998-99 , 2003 , 2008 , 2014	293	264	1,219	1,166	1.9
15	Guinea	1999 , 2005 , 2012	1,137	1,027	195	153	1.6
16	India	1998-99 , 2005-06	1,453	1,317	10,336	8,923	14.0
17	Ivory Coast	2011-12	340	316	295	318	0.8
18	Jordan	1997 , 2012	5,745	5,318	37	49	7.1
19	Kazakhstan	1995	232	257	84	98	0.4
20	Kenya	1998 , 2003 , 2008-09	280	252	2,123	2,042	3.0
21	Kyrgyzstan	1997	431	414	39	24	0.6
22	Liberia	2006-07 , 2013	71	58	416	399	0.6
23	Malawi	2000 , 2004-05 , 2010	673	647	4,501	4,423	6.5
24	Maldives	2009	1,144	1,131	0	0	1.4
25	Mali	1995-96 , 2001 , 2006 2012-2013	2,898	2,739	186	158	3.8
26	Morocco	2003-04	1,148	1,118	0	0	1.4
27	Mozambique	1997 , 2003-04 , 2011	575	562	3,331	3,398	5.0
28	Niger	1998 , 2006 , 2012	1,249	1,156	5	8	1.5
29	Nigeria	1999 , 2003 , 2008 , 2013	1,142	1,145	2,991	2,925	5.2
30	Pakistan	2012-13	235	224	0	0	0.3
31	Senegal	2005 , 2010-11	1,126	1,019	45	45	1.4
32	Sierra Leone	2008 , 2013	1,012	1,118	277	277	1.7
33	Tanzania	1996 , 2004-05	1,054	906	1,498	1,476	3.1
34	Togo	1998 , 2013-14	268	264	936	931	1.5
35	Turkey	1998	771	642	2	5	0.9
36	Uganda	2000-01 , 2006 , 2011	230	225	1,142	1,106	1.7
37	Uzbekistan	1996	513	488	11	14	0.7
	Total		38,889	36,411	41,979	39,814	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.2: Distribution of observations in the analyses of neonatal mortality by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	648	653	131	123	0.3
2	Azerbaijan	2006	1111	933	3	3	0.4
3	Bangladesh	1996-1997 , 1999-2000 2004 , 2007 , 2011	14160	13626	1487	1461	6.0
4	Benin	1996 , 2001 , 2006 2011-2012	3777	3627	11401	11122	5.8
5	Burkina Faso	1992-1993 , 1998-1999 2003 , 2010	5282	5053	3459	3293	3.3
6	Burundi	2010-2011	55	50	1649	1543	0.6
7	Cameroon	1998 , 2004 , 2011	1045	1044	3513	3539	1.8
8	Central Afr. Rep.	1994-1995	100	118	941	898	0.4
9	Chad	1996-1997 , 2004	2990	3012	1857	1724	1.9
10	Comoros	1996 , 2012	1740	1727	6	6	0.7
11	Egypt	1992-1993 , 1995-1996 2005 , 2008 , 2014	23835	22384	1126	990	9.4
12	Ethiopia	1992 , 1997 , 2003	5055	4776	6653	6389	4.5
13	Gabon	2000 , 2012	201	171	2178	2170	0.9
14	Ghana	1993-1994 , 1998-1999 2003 , 2008 , 2014	1062	943	4128	3994	2.0
15	Guinea	1999 , 2005 , 2012	4774	4416	622	608	2.0
16	India	1998-1999 , 2005-06	5812	5417	32199	29421	14.2
17	Ivory Coast	1994 , 2011-12	716	659	640	713	0.5
18	Jordan	1997 , 2012	6492	5967	46	64	2.5
19	Kazakhstan	1995	272	289	89	101	0.1
20	Kenya	1993 , 1998 , 2003 2008-2009	1024	896	5068	4980	2.3
21	Kyrgyzstan	1997	490	477	46	26	0.2
22	Liberia	2006-2007 , 2013	466	365	2987	2861	1.3
23	Malawi	2000 , 2004-2005 , 2010	1730	1774	9743	9676	4.5
24	Maldives	2009	1271	1237	0	0	0.5
25	Mali	1995-1996 , 2001 , 2006 2012-2013	15097	14768	1257	1278	6.3
26	Morocco	1992 , 2003-2004	2783	2697	0	0	1.1
27	Mozambique	1997 , 2003-2004 , 2011	1402	1435	6951	6865	3.3
28	Niger	1992 , 1998 , 2006 , 2012	6719	6281	32	34	2.6
29	Nigeria	1999 , 2003 , 2008 , 2013	17101	16649	12019	11546	11.2
30	Pakistan	2012-2013	1441	1408	0	0	0.6
31	Senegal	2005 , 2010-2011	3108	2864	99	87	1.2
32	Sierra Leone	2008 , 2013	2688	2735	598	614	1.3
33	Tanzania	1991-1992 , 1996 , 2004-05	2282	2246	3698	3642	2.3
34	Togo	1998 , 2013-2014	582	557	2646	2716	1.3
35	Turkey	1998	1573	1382	4	6	0.6
36	Uganda	1995 , 2000-2001 , 2006 2011	597	583	4003	3996	1.8
37	Uzbekistan	1996	630	596	16	16	0.2
	Total		140,111	133,815	121,295	116,505	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.3: Distribution of observations in the analyses of breastfeeding by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	468	495	91	99	0.8
2	Azerbaijan	2006	802	674	2	3	1.0
3	Bangladesh	1996-1997 , 1999-2000 2004 , 2007 , 2011	4067	3827	319	296	5.6
4	Benin	1996 , 2001 , 2006 2011-2012	568	548	2851	2730	4.4
5	Burkina Faso	1998-1999 , 2003 , 2010	943	893	713	703	2.1
6	Burundi	2010-2011	0	2	10	11	0.0
7	Cameroon	1998 , 2004 , 2011	444	438	1751	1782	2.9
8	Central Afr. Rep.	1994-1995	43	33	252	252	0.4
9	Chad	1996-1997 , 2004	1143	1137	763	715	2.5
10	Comoros	1996 , 2012	275	252	0	0	0.3
11	Egypt	1995-1996 , 2005 , 2008 2014	8941	8747	483	408	12.2
12	Ethiopia	1992 , 1997 , 2003	736	749	1561	1540	3.0
13	Gabon	2000 , 2012	61	43	661	663	0.9
14	Ghana	1998-1999 , 2003 , 2008 2014	274	260	1457	1414	2.2
15	Guinea	1999 , 2005 , 2012	481	481	71	72	0.7
16	India	1998-1999 , 2005-06	1587	1528	9490	8877	14.1
17	Ivory Coast	2011-2012	21	27	16	18	0.1
18	Jordan	1997 , 2012	2319	2227	31	42	3.0
19	Kazakhstan	1995	130	144	59	72	0.3
20	Kenya	1998 , 2003 , 2008-2009	388	363	2314	2332	3.6
21	Kyrgyzstan	1997	232	195	29	16	0.3
22	Liberia	2006-2007 , 2013	122	92	872	857	1.3
23	Malawi	2000 , 2004-2005 , 2010	759	769	4465	4589	7.0
24	Maldives	2009	531	527	0	0	0.7
25	Mali	1995-1996 , 2001 , 2006 2012-2013	4064	4061	363	303	5.8
26	Morocco	2003-2004	1867	1805	0	0	2.4
27	Mozambique	1997 , 2003-2004 , 2011	256	271	1485	1536	2.3
28	Niger	1998 , 2006 , 2012	900	809	5	4	1.1
29	Nigeria	1999 , 2003 , 2008 , 2013	3825	3721	3618	3371	9.6
30	Pakistan	2012-2013	34	31	0	0	0.0
31	Senegal	2005 , 2010-2011	543	526	17	18	0.7
32	Sierra Leone	2008 , 2013	385	367	116	98	0.6
33	Tanzania	1996 , 2004-2005	1158	1074	1837	1772	3.8
34	Togo	1998 , 2013-2014	60	66	297	311	0.5
35	Turkey	1998	815	701	3	5	1.0
36	Uganda	2000-2001 , 2006 , 2011	219	230	1471	1480	2.2
37	Uzbekistan	1996	235	253	11	12	0.3
	Total		39,696	38,366	37,484	36,401	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.4: Distribution of observations in the analysis of prolonged labor by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	–	–	–	–	–	–
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1996-1997 , 1999-2000 2004 , 2007	6056	5724	681	620	17.9
4	Benin	1996	159	168	596	569	2.0
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	1998	62	43	219	220	0.7
8	Central Afr. Rep.	1994-1995	79	96	721	700	2.2
9	Chad	1996-1997	257	283	260	219	1.4
10	Comoros	1996	330	279	0	0	0.8
11	Egypt	1995-1996	2475	2172	148	120	6.7
12	Ethiopia	–	–	–	–	–	–
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	2005-2006	1501	1298	9573	7918	27.7
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	1997	1681	1524	27	37	4.5
19	Kazakhstan	1995	200	235	80	88	0.8
20	Kenya	1998	61	54	1019	1011	2.9
21	Kyrgyzstan	1997	402	369	39	23	1.1
22	Liberia	–	–	–	–	–	–
23	Malawi	–	–	–	–	–	–
24	Maldives	–	–	–	–	–	–
25	Mali	1995-1996	1236	1261	98	98	3.7
26	Morocco	–	–	–	–	–	–
27	Mozambique	1997 , 2003-2004	441	453	2409	2393	7.8
28	Niger	1998 , 2006	1128	1024	6	9	3.0
29	Nigeria	1999 , 2003	1034	1089	972	937	5.5
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	1996	598	598	945	958	4.2
34	Togo	1998	186	212	1098	1104	3.5
35	Turkey	1998	913	732	3	4	2.3
36	Uganda	–	–	–	–	–	–
37	Uzbekistan	1996	478	433	11	14	1.3
	Total		19,277	18,047	18,905	17,042	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.5: Distribution of observations in the analysis of maternal excessive bleeding during and after delivery by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	–	–	–	–	–	–
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1996-1997 , 1999-2000 2004 , 2007	6049	5718	680	619	14.4
4	Benin	1996	159	168	596	569	1.6
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	1998	62	43	219	220	0.6
8	Central Afr. Rep.	1994-1995	79	96	721	700	1.8
9	Chad	1996-1997	257	283	260	219	1.1
10	Comoros	1996	330	280	0	0	0.7
11	Egypt	1995-1996	2475	2172	148	120	5.4
12	Ethiopia	–	–	–	–	–	–
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	1998-1999 , 2005-2006	2726	2366	17705	14912	41.6
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	1997	1681	1524	27	37	3.6
19	Kazakhstan	1995	200	235	80	88	0.7
20	Kenya	1998	61	54	1017	1011	2.4
21	Kyrgyzstan	1997	402	369	39	23	0.9
22	Liberia	–	–	–	–	–	–
23	Malawi	–	–	–	–	–	–
24	Maldives	–	–	–	–	–	–
25	Mali	1995-1996	1235	1261	98	98	3.0
26	Morocco	–	–	–	–	–	–
27	Mozambique	1997 , 2003-2004	441	453	2411	2392	6.3
28	Niger	1998 , 2006	1124	1023	6	9	2.4
29	Nigeria	1999 , 2003	1034	1083	961	927	4.4
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	1996	598	597	945	958	3.4
34	Togo	1998	186	212	1097	1104	2.9
35	Turkey	1998	912	733	3	4	1.8
36	Uganda	–	–	–	–	–	–
37	Uzbekistan	1996	478	433	11	14	1.0
	Total		20,489	19,103	27,024	24,024	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.6: Distribution of observations in the analysis of postpartum uterus infection by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	–	–	–	–	–	–
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1996-1997 , 1999-2000 2004 , 2007	6052	5722	681	619	18.6
4	Benin	1996	159	168	596	569	2.1
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	1998	62	43	219	220	0.8
8	Central Afr. Rep.	1994-1995	79	96	721	700	2.3
9	Chad	1996-1997	257	283	259	219	1.4
10	Comoros	1996	330	279	0	0	0.9
11	Egypt	1995-1996	2475	2172	148	120	7.0
12	Ethiopia	–	–	–	–	–	–
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	1998-1999	1224	1067	8125	6993	24.7
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	1997	1681	1524	27	37	4.6
19	Kazakhstan	1995	200	235	80	88	0.9
20	Kenya	1998	61	54	1018	1011	3.0
21	Kyrgyzstan	1997	402	369	39	23	1.2
22	Liberia	–	–	–	–	–	–
23	Malawi	–	–	–	–	–	–
24	Maldives	–	–	–	–	–	–
25	Mali	1995-1996	1235	1260	98	98	3.8
26	Morocco	–	–	–	–	–	–
27	Mozambique	1997 , 2003-2004	441	453	2411	2391	8.1
28	Niger	1998 , 2006	1125	1023	6	9	3.1
29	Nigeria	1999 , 2003	1032	1081	961	927	5.7
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	1996	597	596	945	958	4.4
34	Togo	1998	186	212	1098	1104	3.7
35	Turkey	1998	912	732	3	4	2.3
36	Uganda	–	–	–	–	–	–
37	Uzbekistan	1996	478	433	11	14	1.3
	Total		18,988	17,802	17,446	16,104	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.7: Distribution of observations in the analysis of convulsion during delivery by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	–	–	–	–	–	–
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1996-97 , 1999-2000 2004 , 2007	6047	5715	681	619	17.9
4	Benin	1996	159	168	594	568	2.0
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	1998	62	43	217	219	0.7
8	Central Afr. Rep.	1994-1995	79	96	721	699	2.2
9	Chad	1996-1997	257	283	259	219	1.4
10	Comoros	1996	330	279	0	0	0.8
11	Egypt	1995-1996	2475	2172	148	120	6.7
12	Ethiopia	–	–	–	–	–	–
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	2005-2006	1501	1298	9573	7916	27.7
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	1997	1681	1524	27	37	4.5
19	Kazakhstan	1995	200	235	80	88	0.8
20	Kenya	1998	61	54	1019	1011	2.9
21	Kyrgyzstan	1997	402	369	39	23	1.1
22	Liberia	–	–	–	–	–	–
23	Malawi	–	–	–	–	–	–
24	Maldives	–	–	–	–	–	–
25	Mali	1995-1996	1233	1260	97	98	3.7
26	Morocco	–	–	–	–	–	–
27	Mozambique	1997 , 2003-2004	440	453	2410	2391	7.8
28	Niger	1998 , 2006	1125	1020	6	9	3.0
29	Nigeria	1999 , 2003	1027	1073	954	921	5.4
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	1996	598	594	944	958	4.2
34	Togo	1998	186	212	1098	1102	3.6
35	Turkey	1998	910	732	3	4	2.3
36	Uganda	–	–	–	–	–	–
37	Uzbekistan	1996	478	433	11	14	1.3
	Total		19,251	18,013	18,881	17,016	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.8: Distribution of observations in the analysis of headache, blurry vision, and abdominal pain during pregnancy by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	–	–	–	–	–	–
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1999-2000 , 2004	3177	3008	369	335	10.8
4	Benin	–	–	–	–	–	–
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	–	–	–	–	–	–
8	Central Afr. Rep.	–	–	–	–	–	–
9	Chad	–	–	–	–	–	–
10	Comoros	–	–	–	–	–	–
11	Egypt	–	–	–	–	–	–
12	Ethiopia	2003	1323	1218	1569	1599	8.9
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	1998-1999 , 2005-2006	2940	2604	19097	16117	63.8
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	–	–	–	–	–	–
19	Kazakhstan	–	–	–	–	–	–
20	Kenya	–	–	–	–	–	–
21	Kyrgyzstan	–	–	–	–	–	–
22	Liberia	–	–	–	–	–	–
23	Malawi	2004-2005	450	425	2218	2132	8.2
24	Maldives	–	–	–	–	–	–
25	Mali	–	–	–	–	–	–
26	Morocco	–	–	–	–	–	–
27	Mozambique	2003-2004	309	302	1539	1541	5.8
28	Niger	–	–	–	–	–	–
29	Nigeria	–	–	–	–	–	–
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	–	–	–	–	–	–
34	Togo	–	–	–	–	–	–
35	Turkey	1998	915	734	3	4	2.6
36	Uganda	–	–	–	–	–	–
37	Uzbekistan	–	–	–	–	–	–
	Total		9,114	8,291	24,795	21,728	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.9: Distribution of observations in the analysis of bleeding during pregnancy by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	534	495	111	100	1.9
2	Azerbaijan	–	–	–	–	–	–
3	Bangladesh	1999-2000 , 2004	3176	3008	369	335	10.5
4	Benin	–	–	–	–	–	–
5	Burkina Faso	–	–	–	–	–	–
6	Burundi	–	–	–	–	–	–
7	Cameroon	–	–	–	–	–	–
8	Central Afr. Rep.	–	–	–	–	–	–
9	Chad	–	–	–	–	–	–
10	Comoros	–	–	–	–	–	–
11	Egypt	–	–	–	–	–	–
12	Ethiopia	2003	1323	1218	1569	1599	8.7
13	Gabon	–	–	–	–	–	–
14	Ghana	–	–	–	–	–	–
15	Guinea	–	–	–	–	–	–
16	India	1998-1999 , 2005-2006	2940	2601	19092	16108	62.0
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	–	–	–	–	–	–
19	Kazakhstan	–	–	–	–	–	–
20	Kenya	–	–	–	–	–	–
21	Kyrgyzstan	–	–	–	–	–	–
22	Liberia	–	–	–	–	–	–
23	Malawi	2004-2005	450	425	2218	2132	8.0
24	Maldives	–	–	–	–	–	–
25	Mali	–	–	–	–	–	–
26	Morocco	–	–	–	–	–	–
27	Mozambique	2003-2004	309	300	1541	1543	5.6
28	Niger	–	–	–	–	–	–
29	Nigeria	–	–	–	–	–	–
30	Pakistan	–	–	–	–	–	–
31	Senegal	–	–	–	–	–	–
32	Sierra Leone	–	–	–	–	–	–
33	Tanzania	–	–	–	–	–	–
34	Togo	–	–	–	–	–	–
35	Turkey	1998	916	734	3	4	2.5
36	Uganda	2000-2001	58	43	206	210	0.8
37	Uzbekistan	–	–	–	–	–	–
	Total		9,706	8,824	25,109	22,031	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table A.10: Distribution of observations in the analysis of night blindness during pregnancy by country, survey, religion and sex

			Muslims		Non-Muslims		% in
	Country	Survey Years	Boys	Girls	Boys	Girls	Total
1	Albania	2008-2009	544	499	111	102	0.9
2	Azerbaijan	2006	816	629	2	2	1.1
3	Bangladesh	2004	2170	2089	231	208	3.5
4	Benin	2001 , 2006	650	635	3109	3282	5.8
5	Burkina Faso	2003	1065	1076	837	733	2.8
6	Burundi	–	–	–	–	–	–
7	Cameroon	2004	130	114	575	585	1.1
8	Central Afr. Rep.	–	–	–	–	–	–
9	Chad	2004	617	622	250	283	1.3
10	Comoros	–	–	–	–	–	–
11	Egypt	–	–	–	–	–	–
12	Ethiopia	1992 , 1997	1010	908	2357	2236	4.9
13	Gabon	2000	50	39	576	624	1.0
14	Ghana	2003 , 2008	345	295	1332	1280	2.5
15	Guinea	2005	387	397	61	46	0.7
16	India	1998-99 , 2005-2006	2939	2604	19093	16112	30.8
17	Ivory Coast	–	–	–	–	–	–
18	Jordan	–	–	–	–	–	–
19	Kazakhstan	–	–	–	–	–	–
20	Kenya	2008-2009	280	221	1198	1139	2.1
21	Kyrgyzstan	–	–	–	–	–	–
22	Liberia	–	–	–	–	–	–
23	Malawi	2000 , 2004-05	863	912	4658	4608	8.3
24	Maldives	2009	991	996	0	0	1.5
25	Mali	2001 , 2006	3415	3328	296	275	5.5
26	Morocco	2003-2004	1989	1883	0	0	2.9
27	Mozambique	2003-2004	309	301	1540	1543	2.8
28	Niger	2006	726	677	3	7	1.1
29	Nigeria	2003 , 2008	4215	4241	3450	3354	11.5
30	Pakistan	–	–	–	–	–	–
31	Senegal	2005	690	617	18	26	1.0
32	Sierra Leone	2008	476	480	135	136	0.9
33	Tanzania	2004-2005	861	785	1191	1239	3.1
34	Togo	–	–	–	–	–	–
35	Turkey	–	–	–	–	–	–
36	Uganda	2000-2001 , 2006	254	230	1584	1563	2.7
37	Uzbekistan	–	–	–	–	–	–
	Total		25,792	24,578	42,607	39,383	100

Data Source: Demographic and health surveys, the DHS Program, USAID.

Appendix B: Controlled correlation of exposure to Ramadan with a child's parents' and household's characteristics

Estimations of the effect of an hour of exposure to Ramadan during the 270-day and three 90-day periods before birth on children's parents' and household's characteristics

Exposure Measure	Urban	Birth Order	Mother's Years of Education	Father's Years of Education	Mother's Age at Birth	Father's Age at Birth	Mother's Height	Household Wealth Score
				Muslims				
HER270b	4.42e-06	-4.57e-05	0.000138***	-6.94e-05	4.68e-06	-2.92e-06	-0.000101	-1.92e-05
	(5.88e-06)	(5.76e-05)	(4.16e-05)	(4.40e-05)	(0.000131)	(0.000164)	(9.10e-05)	(2.10e-05)
HER190b	2.65e-06	-5.84e-05	0.000176***	-0.000192**	5.71e-06	0.000130	-0.000125	-2.28e-06
	(9.10e-06)	(5.22e-05)	(4.94e-05)	(7.72e-05)	(0.000122)	(0.000216)	(0.000116)	(2.13e-05)
HER290b	1.20e-05*	-1.85e-05	0.000159***	-9.43e-05	-3.53e-05	-5.28e-05	-0.000108	-2.59e-05
	(6.14e-06)	(5.76e-05)	(5.42e-05)	(6.37e-05)	(0.000137)	(0.000161)	(0.000122)	(2.29e-05)
HER390b	-4.72e-07	-5.68e-05	7.89e-05	7.92e-05	3.92e-05	-9.47e-05	-7.12e-05	-3.06e-05
	(6.92e-06)	(7.27e-05)	(5.69e-05)	(5.79e-05)	(0.000166)	(0.000186)	(0.000116)	(2.89e-05)
Obs.	165,256	165,256	165,189	163,769	165,256	165,256	165,256	165,256
				Non-Muslims				
HER270b	-4.72e-06	7.95e-06	-6.74e-05	3.42e-05	-0.000100	0.000114	-0.000145	2.22e-05
	(4.71e-06)	(3.27e-05)	(4.10e-05)	(6.87e-05)	(8.99e-05)	(0.000138)	(0.000109)	(1.96e-05)
HER190b	-1.95e-06	6.89e-06	2.04e-06	-4.33e-05	-0.000161	0.000427**	-0.000200	2.23e-05
	(6.40e-06)	(2.91e-05)	(4.51e-05)	(8.91e-05)	(9.70e-05)	(0.000209)	(0.000138)	(1.81e-05)
HER290b	1.67e-06	4.11e-05	-0.000101**	0.000163**	-0.000185	4.42e-05	-4.75e-05	7.34e-06
	(7.31e-06)	(5.13e-05)	(4.18e-05)	(7.76e-05)	(0.000129)	(0.000176)	(0.000132)	(2.78e-05)
HER390b	-1.17e-05	-1.29e-05	-0.000115	2.60e-05	1.67e-05	-0.000152	-0.000156	3.19e-05
	(7.40e-06)	(4.40e-05)	(7.08e-05)	(7.64e-05)	(0.000115)	(0.000126)	(0.000142)	(2.14e-05)
Obs.	143,623	143,623	143,580	142,928	143,623	143,623	143,623	143,623

Notes: Each entry of the table is the effect of an hour exposure to Ramadan during a pre-birth episode, specified in the first column, on a child's characteristics, specified in the top row. Exposure measure are HER270b, HER190b, HER290b, and HER390b. Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth, while variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. The reported numbers are estimated coefficients of the exposure measures (listed in the first column from left) in the regressions in which the left-hand-side variable is any of the characteristics listed on the top row and the right-hand-side variables are exposure measure(s) and the rest of the control variables. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. For both subgroups, i.e. Muslims and non-Muslim, male and female children are pooled. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Appendix C: The results of height regressions

Table C.1: The ffect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score by sex, religion and age

Age	Measure of Exposure	Boys			Girls		
		All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
0	HER270b	-0.000134	1.03e-05	0.000144	0.000107	0.000221	0.000114
		(0.000162)	(0.000111)	(0.000112)	(0.000181)	(0.000154)	(0.000109)
	Obs.	38,360	19,975	18,385	37,253	19,274	17,979
1	HER270b	7.29e-05	1.38e-05	-5.91e-05	0.000324**	0.000214**	-0.000110
		(0.000144)	(8.61e-05)	(0.000103)	(0.000126)	(9.96e-05)	(8.41e-05)
	Obs.	34,948	18,027	16,921	33,607	17,285	16,322
2	HER270b	-5.81e-05	-5.19e-05	6.26e-06	0.000165	0.000135	-3.01e-05
		(0.000131)	(9.12e-05)	(7.06e-05)	(0.000133)	(9.28e-05)	(9.81e-05)
	Obs.	32,276	16,845	15,431	31,181	16,257	14,924
3	HER270b	-0.000169	-7.15e-05	9.78e-05	0.000113	-1.81e-05	-0.000131
		(0.000159)	(0.000117)	(0.000124)	(0.000189)	(9.56e-05)	(0.000156)
	Obs.	27,082	15,347	11,735	26,008	14,835	11,173
4	HER270b	-0.000259*	-0.000202***	5.74e-05	3.34e-05	5.30e-05	1.96e-05
		(0.000138)	(5.62e-05)	(0.000101)	(0.000120)	(0.000104)	(8.07e-05)
	Obs.	24,720	14,070	10,650	23,444	13,341	10,103

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table C.2: The effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age Z-score by sex, religion and age

Age	Measures of Exposure	Boys			Girls		
		All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
0	HER190b	-0.000112	-8.81e-07	0.000111	7.14e-05	0.000123	5.15e-05
		(0.000218)	(0.000139)	(0.000172)	(0.000212)	(0.000193)	(0.000135)
	HER290b	-6.78e-05	-2.26e-05	4.53e-05	-1.32e-05	0.000151	0.000165
		(0.000192)	(0.000147)	(0.000128)	(0.000185)	(0.000116)	(0.000131)
	HER390b	-0.000195	5.11e-05	0.000246**	0.000261	0.000409*	0.000148
		(0.000168)	(0.000146)	(9.76e-05)	(0.000240)	(0.000213)	(0.000115)
	Obs.	38,360	19,975	18,385	37,253	19,274	17,979
1	HER190b	0.000122	2.30e-05	-9.87e-05	0.000346**	0.000179	-0.000167
		(0.000187)	(0.000108)	(0.000142)	(0.000168)	(0.000131)	(0.000120)
	HER290b	-6.75e-05	-4.64e-05	2.11e-05	0.000287	0.000295**	7.78e-06
		(0.000183)	(0.000125)	(0.000135)	(0.000204)	(0.000132)	(0.000145)
	HER390b	0.000129	6.08e-05	-6.85e-05	0.000303*	0.000175	-0.000129
		(0.000165)	(0.000109)	(0.000101)	(0.000150)	(0.000122)	(8.44e-05)
	Obs.	34,948	18,027	16,921	33,607	17,285	16,322
2	HER190b	6.07e-06	-4.04e-06	-1.01e-05	0.000190	0.000144	-4.52e-05
		(0.000161)	(0.000133)	(9.12e-05)	(0.000198)	(0.000130)	(0.000142)
	HER290b	-0.000142	-8.93e-05	5.23e-05	0.000120	0.000142	2.13e-05
		(0.000212)	(0.000120)	(0.000129)	(0.000209)	(0.000130)	(0.000157)
	HER390b	-6.26e-05	-6.88e-05	-6.22e-06	0.000166	0.000118	-4.78e-05
		(0.000132)	(0.000112)	(7.86e-05)	(0.000123)	(1.00e-04)	(8.61e-05)
	Obs.	32,276	16,845	15,431	31,181	16,257	14,924
3	HER190b	-0.000179	-2.48e-05	0.000154	6.81e-05	2.14e-05	-4.67e-05
		(0.000180)	(0.000130)	(0.000130)	(0.000228)	(8.97e-05)	(0.000205)
	HER290b	3.05e-05	9.40e-05	6.36e-05	0.000153	2.21e-05	-0.000131
		(0.000224)	(0.000136)	(0.000188)	(0.000266)	(0.000132)	(0.000205)
	HER390b	-0.000320*	-0.000264*	5.55e-05	0.000117	-9.19e-05	-0.000209
		(0.000177)	(0.000145)	(0.000151)	(0.000186)	(0.000136)	(0.000130)
	Obs.	27,082	15,347	11,735	26,008	14,835	11,173
4	HER190b	-0.000175	-6.98e-05	0.000105	9.61e-05	9.20e-05	-4.04e-06
		(0.000168)	(8.79e-05)	(0.000141)	(0.000205)	(0.000172)	(0.000118)
	HER290b	-0.000445**	-0.000298***	0.000147	3.06e-05	4.62e-05	1.56e-05
		(0.000167)	(7.82e-05)	(0.000139)	(0.000141)	(9.98e-05)	(0.000108)
	HER390b	-0.000249	-0.000273***	-2.37e-05	-2.95e-05	1.47e-05	4.41e-05
		(0.000216)	(9.76e-05)	(0.000156)	(0.000132)	(9.63e-05)	(0.000120)
	Obs.	24,720	14,070	10,650	23,444	13,341	10,103

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each set of coefficients of the exposure measures are estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table C.3: The effect of an hour of exposure to Ramadan during nine 30-day periods (months) before birth on 0, 1, and 2 years old male children's height-for-age Z-score by religion and age

Measures of Exposure	Age=0			Age=1			Age=2		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
HER130b	-0.000137	-0.000160	-2.22e-05	0.000382	0.000138	-0.000244	-7.58e-05	-2.37e-05	5.21e-05
	(0.000326)	(0.000226)	(0.000193)	(0.000251)	(0.000185)	(0.000171)	(0.000266)	(0.000161)	(0.000237)
HER230b	-0.000338	1.29e-05	0.000351	0.000188	-3.17e-05	-0.000220	0.000207	0.000102	-0.000104
	(0.000348)	(0.000185)	(0.000274)	(0.000288)	(0.000178)	(0.000190)	(0.000290)	(0.000190)	(0.000181)
HER330b	0.000221	9.53e-05	-0.000125	-0.000177	6.99e-06	0.000184	-0.000159	-0.000173	-1.42e-05
	(0.000321)	(0.000332)	(0.000167)	(0.000268)	(0.000176)	(0.000176)	(0.000192)	(0.000141)	(0.000150)
HER430b	-0.000133	-3.39e-05	9.95e-05	0.000119	8.86e-05	-3.01e-05	-0.000207	0.000172	0.000379*
	(0.000254)	(0.000147)	(0.000232)	(0.000201)	(0.000164)	(0.000164)	(0.000377)	(0.000267)	(0.000207)
HER530b	0.000191	-1.87e-05	-0.000210	0.000165	4.70e-05	-0.000118	8.82e-06	-0.000137	-0.000146
	(0.000285)	(0.000219)	(0.000141)	(0.000267)	(0.000196)	(0.000188)	(0.000238)	(0.000225)	(0.000114)
HER630b	-0.000346	-5.92e-05	0.000287	-0.000513	-0.000272	0.000241	-0.000249	-0.000311	-6.25e-05
	(0.000308)	(0.000250)	(0.000200)	(0.000318)	(0.000182)	(0.000234)	(0.000278)	(0.000207)	(0.000198)
HER730b	-0.000292	-7.18e-05	0.000221	0.000407*	0.000266	-0.000141	-0.000176	3.98e-06	0.000180
	(0.000273)	(0.000230)	(0.000206)	(0.000215)	(0.000168)	(0.000166)	(0.000281)	(0.000167)	(0.000191)
HER830b	-1.34e-05	0.000279*	0.000292	-7.97e-05	-0.000114	-3.45e-05	-5.90e-05	-2.47e-06	5.66e-05
	(0.000235)	(0.000156)	(0.000194)	(0.000203)	(0.000155)	(0.000169)	(0.000181)	(0.000149)	(0.000115)
HER930b	-0.000304	-0.000170	0.000134	0.000170	0.000130	-3.96e-05	4.80e-05	-0.000258	-0.000306*
	(0.000276)	(0.000213)	(0.000155)	(0.000303)	(0.000240)	(0.000180)	(0.000311)	(0.000268)	(0.000157)
Obs.	38,360	19,975	18,385	34,948	18,027	16,921	32,276	16,845	15,431

Notes: Variables HER130b, HER230b, ... , and HER930b contain hours of exposure to Ramadan during the first, second, ... , and ninth 30-day periods (months) before birth. Each set of coefficients of the exposure measures are estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Data Source: Demographic and health surveys, the DHS Program, USAID.

Table C.3 (continued): The effect of an hour of exposure to Ramadan during nine 30-day periods (months) before birth on 3 and 4 years old male children's height-for-age Z-score by religion and age

Measures of Exposure	Age=3			Age=4		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
HER130b	-0.000338	-0.000174	0.000164	-7.07e-05	-8.37e-05	-1.29e-05
	(0.000270)	(0.000124)	(0.000241)	(0.000254)	(0.000138)	(0.000213)
HER230b	3.97e-05	0.000133	9.28e-05	-0.000256	-4.49e-05	0.000211
	(0.000318)	(0.000218)	(0.000244)	(0.000189)	(0.000119)	(0.000169)
HER330b	-0.000347	-8.12e-05	0.000266	-0.000188	-0.000121	6.72e-05
	(0.000255)	(0.000132)	(0.000193)	(0.000314)	(0.000184)	(0.000271)
HER430b	-0.000149	-0.000107	4.21e-05	-0.000730***	-0.000252***	0.000478**
	(0.000412)	(0.000245)	(0.000292)	(0.000211)	(8.71e-05)	(0.000227)
HER530b	3.43e-05	0.000237	0.000203	-0.000231	-0.000316*	-8.47e-05
	(0.000260)	(0.000180)	(0.000231)	(0.000301)	(0.000177)	(0.000200)
HER630b	0.000175	0.000102	-7.31e-05	-0.000413*	-0.000312**	0.000102
	(0.000253)	(0.000153)	(0.000192)	(0.000211)	(0.000147)	(0.000190)
HER730b	-0.000350	-0.000197	0.000153	-0.000374	-0.000458**	-8.40e-05
	(0.000313)	(0.000262)	(0.000212)	(0.000310)	(0.000207)	(0.000166)
HER830b	-0.000192	-0.000252	-6.02e-05	9.15e-05	-6.63e-05	-0.000158
	(0.000219)	(0.000169)	(0.000146)	(0.000317)	(0.000134)	(0.000275)
HER930b	-0.000489*	-0.000355	0.000134	-0.000540*	-0.000377**	0.000163
	(0.000262)	(0.000231)	(0.000213)	(0.000271)	(0.000175)	(0.000189)
Obs.	27,082	15,347	11,735	24,720	14,070	10,650

Notes: Variables HER130b, HER230b, ... , and HER930b contain hours of exposure to Ramadan during the first, second, ... , and ninth 30-day periods (months) before birth. Coefficients of the exposure measures are estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Data Source: Demographic and health surveys, the DHS Program, USAID.

Table C.4: The effect of an hour of exposure to Ramadan during nine 30-day periods (months) before birth on 0, 1, and 2 years old female children's height-for-age Z-score by religion and age

Measures of Exposure	Age=0			Age=1			Age=2		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
HER130b	-0.000182	-0.000133	4.87e-05	0.000578**	0.000304*	-0.000274	0.000163	-3.11e-05	-0.000194
	(0.000341)	(0.000285)	(0.000200)	(0.000239)	(0.000178)	(0.000184)	(0.000285)	(0.000115)	(0.000230)
HER230b	0.000375	0.000331	-4.36e-05	0.000139	-5.84e-05	-0.000198	0.000300	0.000328*	2.75e-05
	(0.000263)	(0.000275)	(0.000132)	(0.000258)	(0.000140)	(0.000205)	(0.000254)	(0.000187)	(0.000176)
HER330b	-0.000118	7.09e-05	0.000189	0.000377	0.000386	8.48e-06	1.35e-05	5.73e-05	4.38e-05
	(0.000285)	(0.000120)	(0.000245)	(0.000292)	(0.000249)	(0.000230)	(0.000265)	(0.000172)	(0.000202)
HER430b	-0.000171	0.000215	0.000386*	0.000541*	0.000536***	-4.62e-06	0.000158	0.000255	9.71e-05
	(0.000340)	(0.000221)	(0.000204)	(0.000305)	(0.000196)	(0.000215)	(0.000299)	(0.000223)	(0.000226)
HER530b	-0.000245	-0.000277	-3.24e-05	0.000539*	0.000454**	-8.53e-05	-9.35e-05	0.000268	0.000361**
	(0.000256)	(0.000187)	(0.000199)	(0.000285)	(0.000210)	(0.000212)	(0.000294)	(0.000187)	(0.000163)
HER630b	0.000398	0.000586***	0.000188	-0.000284	-0.000159	0.000125	0.000327	-0.000144	-0.000471**
	(0.000326)	(0.000193)	(0.000224)	(0.000242)	(0.000163)	(0.000160)	(0.000261)	(0.000221)	(0.000205)
HER730b	0.000233	0.000390	0.000157	0.000335	0.000355**	2.04e-05	-0.000103	0.000107	0.000210
	(0.000349)	(0.000310)	(0.000182)	(0.000269)	(0.000166)	(0.000171)	(0.000351)	(0.000181)	(0.000225)
HER830b	0.000315	0.000295	-1.96e-05	0.000444**	9.34e-05	-0.000351**	0.000381	0.000158	-0.000223
	(0.000251)	(0.000212)	(0.000166)	(0.000208)	(0.000156)	(0.000160)	(0.000291)	(0.000174)	(0.000201)
HER930b	0.000122	0.000497**	0.000376***	0.000134	0.000157	2.21e-05	0.000107	6.42e-05	-4.24e-05
	(0.000269)	(0.000237)	(0.000136)	(0.000300)	(0.000193)	(0.000199)	(0.000159)	(0.000120)	(0.000129)
Obs.	37,253	19,274	17,979	33,607	17,285	16,322	31,181	16,257	14,924

Notes: Variables HER130b, HER230b, ... , and HER930b contain hours of exposure to Ramadan during the first, second, ... , and ninth 30-day periods (months) before birth. Coefficients of the exposure measures are estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Data Source: Demographic and health surveys, the DHS Program, USAID.

Table C.4 (continued): The effect of an hour of exposure to Ramadan during nine 30-day periods (months) before birth on 3 and 4 years old male children's height-for-age Z-score by religion and age

Measures of Exposure	Age=3			Age=4		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
HER130b	0.000497*	0.000366*	-0.000131	9.86e-05	6.79e-05	-3.07e-05
	(0.000275)	(0.000187)	(0.000199)	(0.000265)	(0.000216)	(0.000140)
HER230b	-0.000260	-0.000196	6.38e-05	0.000197	0.000183	-1.43e-05
	(0.000385)	(0.000194)	(0.000308)	(0.000295)	(0.000240)	(0.000167)
HER330b	6.01e-05	-1.69e-05	-7.70e-05	-5.25e-05	-3.00e-08	5.24e-05
	(0.000285)	(0.000140)	(0.000291)	(0.000268)	(0.000209)	(0.000203)
HER430b	0.000550*	0.000334*	-0.000216	0.000115	6.41e-05	-5.12e-05
	(0.000317)	(0.000180)	(0.000243)	(0.000208)	(0.000147)	(0.000193)
HER530b	-0.000122	-6.77e-06	0.000115	-4.60e-05	-0.000141	-9.48e-05
	(0.000339)	(0.000163)	(0.000288)	(0.000256)	(0.000195)	(0.000182)
HER630b	0.000136	-0.000201	-0.000337	-3.47e-05	0.000249**	0.000284*
	(0.000409)	(0.000294)	(0.000220)	(0.000185)	(0.000120)	(0.000146)
HER730b	-0.000161	-0.000211	-4.95e-05	-0.000267	0.000124	0.000390*
	(0.000255)	(0.000175)	(0.000177)	(0.000305)	(0.000167)	(0.000214)
HER830b	6.46e-05	-0.000115	-0.000179	-1.79e-05	-0.000154	-0.000136
	(0.000285)	(0.000214)	(0.000184)	(0.000182)	(0.000183)	(0.000159)
HER930b	0.000493**	0.000105	-0.000389**	0.000140	0.000101	-3.95e-05
	(0.000216)	(0.000130)	(0.000185)	(0.000237)	(0.000161)	(0.000195)
Obs.	26,008	14,835	11,173	23,444	13,341	10,103

Notes: Variables HER130b, HER230b, ... , and HER930b contain hours of exposure to Ramadan during the first, second, ... , and ninth 30-day periods (months) before birth. Coefficients of the exposure measures are estimated in a regression for a subgroup of children specified by sex, mother's religion, and age. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Data Source: Demographic and health surveys, the DHS Program, USAID.

Appendix D: Robustness Tests

In a series of tests, I check robustness of the estimated height effects that were discussed in Section (4). More specifically, I reestimate Models (1)–(3) dropping overrepresented countries in the sample, dropping the heaping points of the birth day, using alternative exposure measures, and employing fixed-effect estimation method. I also examine the effect of inclusion of pre-conception and post-birth exposure to Ramadan.

Large fractions of observations in the estimation sample—12.5%, 12.3%, 9.1%, 6.7%, and 5.8% of total observations—are coming from India, Egypt, Nigeria, Bangladesh, and Mali, respectively. To test if the effects on height of pre-birth exposure to Ramadan are driven by observations from these overrepresented countries, I estimate the effects for children at ages 3 and 4 years—the ages at which strong and statistically significant effect appears—excluding observations from each of the five countries. The results, presented in Tables (D.1.1)–(D.1.4) where original results are juxtaposed against the results when any of the countries are dropped, show that statistical significance and pattern of the effects remain unchanged. Particularly, in all cases, exposure during the third and second trimesters before birth has the largest negative effects on children's height at ages 3 and 4, respectively. Also, the outcomes of the month regressions, although not reported, show similar pattern to the original results.[51]

There are spikes in the number of children who reported 1, 5, 10, 15, 20, or 25 as their day of birth (Figure D.2.1). As another robustness check, I reestimate the original models dropping children born at these days and compare the results with the original ones. In effect, I estimate the models for 3- and 4-year-old children when all heaped points of the day of birth—*i.e.*, 1, 5, 10, 15, 20, and 25—are dropped and when only the highly heaped points of the day of birth—*i.e.*, 1, 5, 10, and 20—are dropped. The results, presented in Tables (D.2.1)–(D.2.4) in which original results are given alongside the new results, show that the pattern of the effects are preserved after dropping the heaping points, especially when only highly heaped points are dropped.

In the original regressions, I estimate the effect of "hours" of exposure to Ramadan during different episodes before birth on height. To test the robustness of the results against different measures of exposure, I reestimate the models for 3- and 4-year-old children when "days" or "indicators" of exposure are used.[52] As another set of exposure measures, I separate partial exposure at the beginning and end of gestation from full exposure. Tables (D.3.1)–(D.3.4), where the new results are juxtaposed against original ones, show that the pattern of the effects remains unchanged when alternative exposure measures are examined, although there are minor differences in the magnitude of the effects.[53]

To address family- and household-level unobserved factors that may influence the timing of conception or the intention to treat, I conduct fixed-effect analysis in which the identification is driven from the comparison of the exposed and non-exposed siblings of the same mother or from the same household. Since it is rare to have a mother with more than one child at the same year of age, it is not possible to run age-specific fixed-effect regressions. In Tables (D.4.1)–(D.4.2), the

[51] In addition, it can be seen that dropping either India, Egypt, or Mali results in rather smaller effects than those in the original regressions. On the other hand, dropping either Nigeria or Bangladesh results in rather greater effects than those in the original regressions. One possible explanation of the changes in results is the difference in observance of Ramadan—*i.e.*, intention to treat—among these two groups of countries: observance may be higher in India, Egypt, and Mali but lower in Nigeria and Bangladesh than the average observance in the sample.

[52] An indicator of exposure is a dummy variable that contains 1 when a child is exposed to Ramadan during the pre-birth episode of interest; 0 otherwise.

[53] The hours of exposure coefficients times 12—the average hours of daylight during a Ramadan in the sample—are comparable to the days of exposure coefficients. Also, hours of exposure coefficients times 12×30 are comparable to the indicators of exposure coefficients because most exposed children are exposed to a full Ramadan.

results of fixed-effect regressions are compared to the original OLS regressions when children of all ages are pooled. Although negative in sign, the OLS results are not statistically significant. However, the fixed-effect results are both negative in sign and statistically significant. Interpreting the estimated fixed-effect coefficients is not straightforward because the exposed and non-exposed children of different mothers or households can have different age differentials. For example, for one mother, the exposed and non-exposed children can be at ages 4 years and 0 year, respectively. For another mother however they can be at ages 2 years and 0 year, respectively. The estimated coefficients therefore are averages over such and other possible cases.[54] Nonetheless, it can be seen that the magnitude of the coefficients in mothers' fixed-effect regressions are comparable to magnitude of the OLS coefficients at late childhood, which are presented in Tables (C.1) and (C.2). This should be at no surprise given the fact that the height effect is more significant and distinctive at late childhood.

I also investigate the case for inclusion of pre-conception measures of exposure to Ramadan and its impact on the results. Since Ramadan reoccurs every year, it is essentially different than one-time nutritional shocks—such as human and natural disasters like famines, tornadoes, and wars—that are usually used in the literature. Therefore, going backwards from birth to more than 9 or 10 months results in two problems. First, going beyond 12 months will remain no child who is counted as non-exposed then no reference group for comparisons. Second, going beyond 9 or 10 months shrinks the comparison group. As an example, in Tables (D.5.1)–(D.5.2), I have presented the estimated coefficients of height regressions in which hours of exposure during pre-conception months are gradually included for 4-year-old male children. As it can be seen, gradual inclusion of preconception measures results in dissipation of the effects such that no effect can be detected when exposure during month 12 or more before birth are included.

In addition, I investigate the case for inclusion of post-birth measures of exposure to Ramadan. In fact, when examining height effect of exposure to Ramadan during months 9, 8, ... , 2, and 1 before birth, I am dividing the exposed children into 9 groups and comparing them with those who were not exposed to Ramadan, or were exposed during months 10, 11, and 12 before birth. Any member of any of the groups of the exposed children was also exposed to Ramadan after birth. For example, a child who was exposed to Ramadan during month 9 before birth was also exposed to Ramadans during months 4, 16, 27, and 39 after birth. Or, a child who was exposed to Ramadan during month 8 before birth was also exposed to Ramadans during months 5, 17, 28, and 40 after birth. Therefore, the comparison of the effects of exposure to Ramadan in months 9 and 8 before birth embeds the comparison of the effects of exposure during the following two series of Ramadans after birth: months (4, 16, 27, 39) and months (5, 17, 28, 40). The question is how much of the measured effects are attributable to post-birth Ramadans. The differential effect of post-birth Ramadans is probably minor because members of the control group—children who were exposed to Ramadan during months 10, 11, 12 before birth—are also exposed to the same number of post birth Ramadans. Then, it is expected that the comparison of the treatment and control groups cancels out the effects of post-birth Ramadans.[55] As a result, I do not need to separately examine post-birth exposure measures.

[54] To have a straightforward interpretation of the fixed-effect coefficients, one can include pairs of children at specific ages in separate regressions. Focusing on the effect of exposure on height at age 4 years, when it is expected that the effect on height is most significant, the relevant pairs of children in terms of age are (4,3), (4,2), (4,1), and (4,0) where the second component of the pairs are the ages of the non-exposed children of the same sex and mother/household. The regression sample however is not large enough to provide enough variation to conduct such analyses.

[55] Since post-birth exposures happened at different months for the groups of children specified by the timing of their pre-birth exposure, I do not expect that the effects of post-birth exposures "completely" cancel each other out.

D.1: Dropping overrepresented countries

Table D.1.1: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 3 by sex and religion after dropping overrepresented countries from the regression sample

Measure of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no country is dropped):					
HER270b	-0.000169	-7.15e-05	9.78e-05	0.000113	-1.81e-05	-0.000131
	(0.000159)	(0.000117)	(0.000124)	(0.000189)	(9.56e-05)	(0.000156)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	India is dropped:					
HER270b	-0.000128	-7.33e-05	5.48e-05	3.63e-05	-2.59e-05	-6.22e-05
	(0.000167)	(0.000119)	(0.000137)	(0.000190)	(9.59e-05)	(0.000164)
Obs.	24,799	15,053	9,746	23,913	14,537	9,376
	Egypt is dropped:					
HER270b	-0.000103	-6.66e-06	9.61e-05	0.000174	3.22e-05	-0.000142
	(0.000162)	(0.000129)	(0.000128)	(0.000194)	(9.59e-05)	(0.000159)
Obs.	23,164	11,608	11,556	22,360	11,327	11,033
	Nigeria is dropped:					
HER270b	-0.000235	-0.000109	0.000127	0.000126	9.37e-06	-0.000117
	(0.000157)	(0.000113)	(0.000133)	(0.000202)	(0.000101)	(0.000164)
Obs.	24,342	13,816	10,526	23,377	13,291	10,086
	Bangladesh is dropped:					
HER270b	-0.000241	-0.000135	0.000106	9.68e-05	-4.77e-05	-0.000144
	(0.000156)	(0.000117)	(0.000127)	(0.000202)	(0.000107)	(0.000159)
Obs.	24,945	13,415	11,530	24,063	13,060	11,003
	Mali is dropped:					
HER270b	-0.000119	-1.13e-05	0.000108	0.000104	-2.25e-05	-0.000127
	(0.000155)	(0.000113)	(0.000123)	(0.000196)	(0.000106)	(0.000157)
Obs.	25,602	13,984	11,618	24,585	13,499	11,086

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.1.2: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 4 by sex and religion after dropping overrepresented countries from the regression sample

Measure of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no country is dropped):					
HER270b	-0.000259*	-0.000202***	5.74e-05	3.34e-05	5.30e-05	1.96e-05
	(0.000138)	(5.62e-05)	(0.000101)	(0.000120)	(0.000104)	(8.07e-05)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	India is dropped:					
HER270b	-0.000246	-0.000202***	4.34e-05	5.07e-05	6.40e-05	1.34e-05
	(0.000150)	(5.72e-05)	(0.000112)	(0.000125)	(0.000104)	(8.62e-05)
Obs.	22,530	13,801	8,729	21,559	13,095	8,464
	Egypt is dropped:					
HER270b	-0.000176	-0.000147**	2.85e-05	1.16e-05	2.50e-05	1.34e-05
	(0.000137)	(6.28e-05)	(9.90e-05)	(0.000149)	(0.000144)	(8.24e-05)
Obs.	21,177	10,698	10,479	20,086	10,126	9,960
	Nigeria is dropped:					
HER270b	-0.000277*	-0.000207***	6.92e-05	2.49e-05	6.59e-06	-1.83e-05
	(0.000150)	(6.00e-05)	(0.000113)	(0.000130)	(0.000103)	(8.42e-05)
Obs.	22,245	12,652	9,593	21,085	11,986	9,099
	Bangladesh is dropped:					
HER270b	-0.000307**	-0.000227***	8.07e-05	2.93e-05	5.48e-05	2.55e-05
	(0.000145)	(5.93e-05)	(0.000105)	(0.000130)	(0.000114)	(8.29e-05)
Obs.	22,788	12,324	10,464	21,640	11,706	9,934
	Mali is dropped:					
HER270b	-0.000261*	-0.000213***	4.77e-05	5.77e-05	6.87e-05	1.10e-05
	(0.000141)	(5.80e-05)	(0.000102)	(0.000123)	(0.000109)	(8.11e-05)
Obs.	23,441	12,890	10,551	22,216	12,219	9,997

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.1.3: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age Z-score at age 3 by sex and religion after dropping overrepresented countries

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no is country dropped):					
HER190b	-0.000179	-2.48e-05	0.000154	6.81e-05	2.14e-05	-4.67e-05
	(0.000180)	(0.000130)	(0.000130)	(0.000228)	(8.97e-05)	(0.000205)
HER290b	3.05e-05	9.40e-05	6.36e-05	0.000153	2.21e-05	-0.000131
	(0.000224)	(0.000136)	(0.000188)	(0.000266)	(0.000132)	(0.000205)
HER390b	-0.000320*	-0.000264*	5.55e-05	0.000117	-9.19e-05	-0.000209
	(0.000177)	(0.000145)	(0.000151)	(0.000186)	(0.000136)	(0.000130)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	India is dropped:					
HER190b	-0.000146	-2.18e-05	0.000124	-1.34e-05	1.60e-05	2.94e-05
	(0.000189)	(0.000132)	(0.000141)	(0.000226)	(9.09e-05)	(0.000209)
HER290b	4.38e-05	9.67e-05	5.29e-05	6.57e-05	7.23e-06	-5.85e-05
	(0.000238)	(0.000136)	(0.000207)	(0.000259)	(0.000130)	(0.000205)
HER390b	-0.000265	-0.000280*	-1.56e-05	4.96e-05	-9.79e-05	-0.000148
	(0.000185)	(0.000145)	(0.000161)	(0.000196)	(0.000135)	(0.000151)
Obs.	24,799	15,053	9,746	23,913	14,537	9,376
	Egypt is dropped:					
HER190b	-0.000190	-3.80e-05	0.000152	8.18e-06	-5.08e-05	-5.89e-05
	(0.000190)	(0.000150)	(0.000133)	(0.000246)	(0.000105)	(0.000212)
HER290b	9.31e-05	0.000166	7.31e-05	0.000299	0.000120	-0.000178
	(0.000245)	(0.000165)	(0.000194)	(0.000257)	(0.000120)	(0.000207)
HER390b	-0.000145	-9.61e-05	4.85e-05	0.000263	5.97e-05	-0.000204
	(0.000163)	(0.000138)	(0.000157)	(0.000172)	(0.000110)	(0.000132)
Obs.	23,164	11,608	11,556	22,360	11,327	11,033
	Nigeria is dropped:					
HER190b	-0.000285	-0.000119	0.000165	6.87e-06	1.75e-05	1.06e-05
	(0.000187)	(0.000114)	(0.000151)	(0.000241)	(0.000104)	(0.000212)
HER290b	-9.04e-05	2.03e-05	0.000111	0.000160	4.40e-05	-0.000116
	(0.000205)	(0.000116)	(0.000195)	(0.000283)	(0.000142)	(0.000216)
HER390b	-0.000305	-0.000211	9.43e-05	0.000205	-2.72e-05	-0.000232*
	(0.000181)	(0.000149)	(0.000156)	(0.000187)	(0.000128)	(0.000135)
Obs.	24,342	13,816	10,526	23,377	13,291	10,086
	Bangladesh is dropped:					
HER190b	-0.000235	-6.78e-05	0.000167	7.33e-05	3.61e-06	-6.97e-05
	(0.000193)	(0.000147)	(0.000130)	(0.000233)	(0.000105)	(0.000206)
HER290b	-5.64e-05	2.03e-05	7.67e-05	0.000115	-2.56e-05	-0.000141
	(0.000224)	(0.000133)	(0.000193)	(0.000281)	(0.000141)	(0.000209)
HER390b	-0.000391**	-0.000336**	5.50e-05	9.72e-05	-0.000118	-0.000215
	(0.000168)	(0.000129)	(0.000156)	(0.000198)	(0.000142)	(0.000134)
Obs.	24,945	13,415	11,530	24,063	13,060	11,003
	Mali is dropped:					
HER190b	-0.000115	4.27e-05	0.000157	7.94e-05	3.11e-05	-4.83e-05
	(0.000181)	(0.000131)	(0.000131)	(0.000234)	(9.86e-05)	(0.000206)
HER290b	9.38e-05	0.000157	6.31e-05	0.000130	1.13e-05	-0.000119
	(0.000214)	(0.000124)	(0.000188)	(0.000271)	(0.000141)	(0.000206)
HER390b	-0.000299	-0.000221	7.76e-05	9.38e-05	-0.000109	-0.000203
	(0.000181)	(0.000154)	(0.000148)	(0.000191)	(0.000145)	(0.000130)
Obs.	25,602	13,984	11,618	24,585	13,499	11,086

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each set of coefficients of the exposure measures are estimated in a regression for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

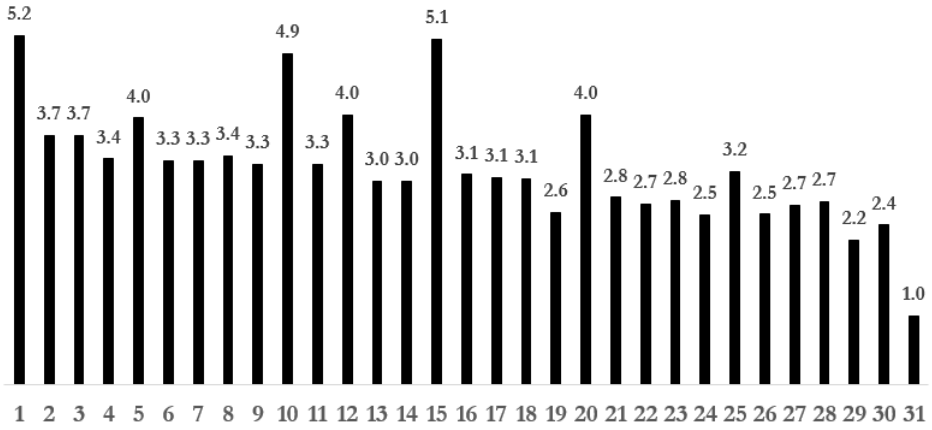
Table D.1.4: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age Z-score at age 4 by sex and religion after dropping overrepresented countries

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no country is dropped):					
HER190b	-0.000175	-6.98e-05	0.000105	9.61e-05	9.20e-05	-4.04e-06
	(0.000168)	(8.79e-05)	(0.000141)	(0.000205)	(0.000172)	(0.000118)
HER290b	-0.000445**	-0.000298***	0.000147	3.06e-05	4.62e-05	1.56e-05
	(0.000167)	(7.82e-05)	(0.000139)	(0.000141)	(9.98e-05)	(0.000108)
HER390b	-0.000249	-0.000273***	-2.37e-05	-2.95e-05	1.47e-05	4.41e-05
	(0.000216)	(9.76e-05)	(0.000156)	(0.000132)	(9.63e-05)	(0.000120)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	India is dropped:					
HER190b	-0.000192	-6.37e-05	0.000128	0.000160	0.000105	-5.47e-05
	(0.000175)	(8.89e-05)	(0.000144)	(0.000207)	(0.000171)	(0.000125)
HER290b	-0.000397**	-0.000298***	9.89e-05	8.46e-06	4.26e-05	3.42e-05
	(0.000172)	(7.88e-05)	(0.000146)	(0.000141)	(0.000101)	(0.000108)
HER390b	-0.000215	-0.000280***	-6.43e-05	-3.35e-05	3.50e-05	6.85e-05
	(0.000229)	(9.76e-05)	(0.000169)	(0.000141)	(9.46e-05)	(0.000124)
Obs.	22,530	13,801	8,729	21,559	13,095	8,464
	Egypt is dropped:					
HER190b	-0.000155	-5.64e-05	9.82e-05	-5.02e-06	-4.61e-05	-4.10e-05
	(0.000175)	(9.33e-05)	(0.000144)	(0.000240)	(0.000198)	(0.000115)
HER290b	-0.000398**	-0.000268**	0.000130	7.98e-05	9.28e-05	1.30e-05
	(0.000187)	(0.000106)	(0.000141)	(0.000170)	(0.000147)	(0.000110)
HER390b	-8.53e-05	-0.000163	-7.76e-05	-1.08e-05	5.51e-05	6.59e-05
	(0.000211)	(0.000110)	(0.000152)	(0.000154)	(0.000151)	(0.000125)
Obs.	21,177	10,698	10,479	20,086	10,126	9,960
	Nigeria is dropped:					
HER190b	-0.000196	-0.000123	7.35e-05	3.97e-06	-4.33e-06	-8.30e-06
	(0.000190)	(8.47e-05)	(0.000159)	(0.000206)	(0.000166)	(0.000130)
HER290b	-0.000390**	-0.000248***	0.000142	3.70e-05	2.44e-05	-1.27e-05
	(0.000181)	(8.01e-05)	(0.000151)	(0.000156)	(9.50e-05)	(0.000125)
HER390b	-0.000306	-0.000269**	3.69e-05	3.51e-05	5.03e-06	-3.00e-05
	(0.000223)	(0.000111)	(0.000153)	(0.000139)	(0.000106)	(0.000106)
Obs.	22,245	12,652	9,593	21,085	11,986	9,099
	Bangladesh is dropped:					
HER190b	-0.000268	-0.000160**	0.000108	9.47e-05	7.78e-05	-1.69e-05
	(0.000169)	(7.23e-05)	(0.000143)	(0.000214)	(0.000183)	(0.000120)
HER290b	-0.000470**	-0.000278***	0.000191	4.07e-05	5.75e-05	1.68e-05
	(0.000176)	(7.38e-05)	(0.000140)	(0.000153)	(0.000114)	(0.000109)
HER390b	-0.000267	-0.000255**	1.19e-05	-4.18e-05	2.89e-05	7.06e-05
	(0.000229)	(9.85e-05)	(0.000159)	(0.000142)	(0.000113)	(0.000122)
Obs.	22,788	12,324	10,464	21,640	11,706	9,934
	Mali is dropped:					
HER190b	-0.000161	-7.62e-05	8.47e-05	0.000151	0.000147	-3.27e-06
	(0.000170)	(9.12e-05)	(0.000141)	(0.000208)	(0.000171)	(0.000120)
HER290b	-0.000445**	-0.000303***	0.000142	8.40e-05	8.27e-05	-1.27e-06
	(0.000171)	(8.23e-05)	(0.000141)	(0.000137)	(0.000101)	(0.000107)
HER390b	-0.000265	-0.000290***	-2.48e-05	-6.18e-05	-3.14e-05	3.05e-05
	(0.000225)	(0.000103)	(0.000158)	(0.000138)	(9.37e-05)	(0.000120)
Obs.	23,441	12,890	10,551	22,216	12,219	9,997

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each set of coefficients of the exposure measures are estimated in a regression for a subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

D.2: Dropping day of birth heaped points

Figure D.2.1: Share of observations at different birth days in the regression sample in percentage



Notes: The horizontal axis in the figure presents days of birth in children's birth month. Each bar shows the percentage of children who are born in the pertinent day in the regression sample, which includes 309,879 children.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.2.1: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 3 by sex and religion after dropping day of birth heaped points from the regression sample

Measure of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no observation is dropped):					
HER270b	-0.000169	-7.15e-05	9.78e-05	0.000113	-1.81e-05	-0.000131
	(0.000159)	(0.000117)	(0.000124)	(0.000189)	(9.56e-05)	(0.000156)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	All heaped birth days are dropped:					
HER270b	-0.000142	-5.70e-05	8.49e-05	-9.44e-08	-6.82e-05	-6.81e-05
	(0.000141)	(9.34e-05)	(0.000129)	(0.000238)	(0.000121)	(0.000193)
Obs.	19,735	10,806	8,929	18,912	10,460	8,452
	Highly heaped birth days are dropped:					
HER270b	-0.000162	-6.57e-05	9.58e-05	0.000110	-4.43e-05	-0.000154
	(0.000138)	(9.46e-05)	(0.000126)	(0.000218)	(0.000107)	(0.000172)
Obs.	22,731	12,583	10,148	21,915	12,238	9,677

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. All heaped birth days are 1st, 5th, 10th, 15th, 20th, and 25th of birth month. Highly heaped birth days are 1st, 10th, and 15th of birth month. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, 10, and 20 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.2.2: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 4 by sex and religion after dropping day of birth heaped points from the regression sample

Measure of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no observation is dropped):					
HER270b	-0.000259*	-0.000202***	5.74e-05	3.34e-05	5.30e-05	1.96e-05
	(0.000138)	(5.62e-05)	(0.000101)	(0.000120)	(0.000104)	(8.07e-05)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	All heaped birth days are dropped:					
HER270b	-0.000160	-0.000109	5.13e-05	-9.43e-05	5.64e-05	0.000151
	(0.000152)	(0.000112)	(9.62e-05)	(0.000146)	(0.000114)	(0.000114)
Obs.	17,988	9,935	8,053	16,988	9,384	7,604
	Highly heaped birth days are dropped:					
HER270b	-0.000262	-0.000197*	6.44e-05	-7.59e-05	5.98e-05	0.000136
	(0.000163)	(0.000104)	(0.000107)	(0.000143)	(0.000117)	(0.000108)
Obs.	20,746	11,526	9,220	19,604	10,926	8,678

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. All heaped birth days are 1st, 5th, 10th, 15th, 20th, and 25th of birth month. Highly heaped birth days are 1st, 10th, and 15th of birth month. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, 10, and 20 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.2.3: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age at age 3 by sex and religion after day of birth heaped points

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no observation is dropped):					
HER190b	-0.000179	-2.48e-05	0.000154	6.81e-05	2.14e-05	-4.67e-05
	(0.000180)	(0.000130)	(0.000130)	(0.000228)	(8.97e-05)	(0.000205)
HER290b	3.05e-05	9.40e-05	6.36e-05	0.000153	2.21e-05	-0.000131
	(0.000224)	(0.000136)	(0.000188)	(0.000266)	(0.000132)	(0.000205)
HER390b	-0.000320*	-0.000264*	5.55e-05	0.000117	-9.19e-05	-0.000209
	(0.000177)	(0.000145)	(0.000151)	(0.000186)	(0.000136)	(0.000130)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	All heaped birth days are dropped:					
HER190b	-0.000120	4.89e-05	0.000169	8.22e-05	4.35e-05	-3.87e-05
	(0.000159)	(9.66e-05)	(0.000151)	(0.000276)	(0.000118)	(0.000251)
HER290b	4.46e-05	3.82e-05	-6.41e-06	2.21e-05	-2.93e-05	-5.14e-05
	(0.000210)	(0.000145)	(0.000171)	(0.000339)	(0.000174)	(0.000260)
HER390b	-0.000290	-0.000252*	3.80e-05	-0.000114	-0.000216	-0.000102
	(0.000180)	(0.000137)	(0.000153)	(0.000214)	(0.000148)	(0.000161)
Obs.	19,735	10,806	8,929	18,912	10,460	8,452
	Highly heaped birth days are dropped:					
HER190b	-0.000160	1.35e-05	0.000174	0.000162	9.83e-06	-0.000152
	(0.000167)	(0.000106)	(0.000142)	(0.000256)	(0.000120)	(0.000224)
HER290b	7.62e-05	9.58e-05	1.96e-05	0.000188	3.26e-05	-0.000156
	(0.000201)	(0.000117)	(0.000182)	(0.000297)	(0.000146)	(0.000224)
HER390b	-0.000331*	-0.000282**	4.81e-05	-5.52e-06	-0.000161	-0.000155
	(0.000164)	(0.000133)	(0.000145)	(0.000206)	(0.000132)	(0.000144)
Obs.	22,731	12,583	10,148	21,915	12,238	9,677

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each set of coefficients of the exposure measures are estimated in a regression for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. All heaped birth days are 1st, 5th, 10th, 15th, 20th, and 25th of birth month. Highly heaped birth days are 1st, 10th, and 15th of birth month. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, 10, and 20 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.2.4: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age at age 4 by sex and religion after day of birth heaped points

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Original results (no observation is dropped):					
HER190b	-0.000175	-6.98e-05	0.000105	9.61e-05	9.20e-05	-4.04e-06
	(0.000168)	(8.79e-05)	(0.000141)	(0.000205)	(0.000172)	(0.000118)
HER290b	-0.000445**	-0.000298***	0.000147	3.06e-05	4.62e-05	1.56e-05
	(0.000167)	(7.82e-05)	(0.000139)	(0.000141)	(9.98e-05)	(0.000108)
HER390b	-0.000249	-0.000273***	-2.37e-05	-2.95e-05	1.47e-05	4.41e-05
	(0.000216)	(9.76e-05)	(0.000156)	(0.000132)	(9.63e-05)	(0.000120)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	All heaped birth days are dropped:					
HER190b	-0.000141	2.45e-05	0.000165	-6.85e-05	2.82e-05	9.67e-05
	(0.000189)	(0.000136)	(0.000145)	(0.000205)	(0.000183)	(0.000136)
HER290b	-0.000260	-0.000147	0.000113	-2.02e-05	9.36e-05	0.000114
	(0.000182)	(0.000122)	(0.000152)	(0.000183)	(0.000122)	(0.000152)
HER390b	-0.000143	-0.000224	-8.05e-05	-0.000158	6.02e-05	0.000218
	(0.000246)	(0.000167)	(0.000149)	(0.000173)	(0.000119)	(0.000141)
Obs.	17,988	9,935	8,053	16,988	9,384	7,604
	Highly heaped birth days are dropped:					
HER190b	-0.000173	-4.35e-05	0.000129	5.83e-05	0.000116	5.80e-05
	(0.000189)	(0.000134)	(0.000132)	(0.000220)	(0.000197)	(0.000128)
HER290b	-0.000428**	-0.000277***	0.000151	-0.000110	4.09e-05	0.000150
	(0.000195)	(0.000100)	(0.000162)	(0.000175)	(0.000104)	(0.000149)
HER390b	-0.000275	-0.000305*	-2.95e-05	-0.000192	1.09e-05	0.000203
	(0.000243)	(0.000152)	(0.000156)	(0.000177)	(0.000116)	(0.000145)
Obs.	20,746	11,526	9,220	19,604	10,926	8,678

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each set of coefficients of the exposure measures are estimated in a regression for subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. All heaped birth days are 1st, 5th, 10th, 15th, 20th, and 25th of birth month. Highly heaped birth days are 1st, 10th, and 15th of birth month. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, 10, and 20 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

D.3: Using alternative exposure measures

Table D.3.1: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 3 by sex and religion using different exposure measures

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Hours of exposure:					
HER270b	-0.000169	-7.15e-05	9.78e-05	0.000113	-1.81e-05	-0.000131
	(0.000159)	(0.000117)	(0.000124)	(0.000189)	(9.56e-05)	(0.000156)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Days of exposure:					
DER270b	-0.00220	-0.000925	0.00128	0.00146	-0.000179	-0.00164
	(0.00188)	(0.00138)	(0.00148)	(0.00230)	(0.00117)	(0.00190)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Indicator of exposure:					
ER270b	-0.0767	-0.0335	0.0432	0.0771	0.0501	-0.0270
	(0.0490)	(0.0352)	(0.0383)	(0.0614)	(0.0367)	(0.0529)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Partial versus full exposure:					
P_HERend	0.000196	5.82e-05	-0.000137	0.00112***	0.00101***	-0.000108
	(0.000335)	(0.000164)	(0.000341)	(0.000341)	(0.000266)	(0.000186)
F_HER270b	-0.000177	-7.76e-05	9.95e-05	0.000125	-6.37e-06	-0.000131
	(0.000159)	(0.000117)	(0.000124)	(0.000185)	(9.17e-05)	(0.000156)
P_HERstart	-0.000638	-0.000350	0.000289	0.000384	0.000192	-0.000192
	(0.000418)	(0.000303)	(0.000283)	(0.000308)	(0.000194)	(0.000272)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173

Notes: Variables HER270b, DER270b, and ER270B contain hours, days, and indicator of exposure to Ramadan during the 270-day period before birth, respectively. F_HER270b contains hours of exposure for those who were exposed to a full 30-day Ramadan during the 270-day period, while P_HERstart and P_HERend contain hours of exposure for those who were partially exposed at the beginning and end of the 270-day period, respectively. Each coefficient (or the set of coefficients) is estimated for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.3.2: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score at age 4 by sex and religion using different exposure measures

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Hours of exposure:					
HER270b	-0.000259*	-0.000202***	5.74e-05	3.34e-05	5.30e-05	1.96e-05
	(0.000138)	(5.62e-05)	(0.000101)	(0.000120)	(0.000104)	(8.07e-05)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Days of exposure:					
DER270b	-0.00331**	-0.00244***	0.000873	0.000309	0.000533	0.000225
	(0.00161)	(0.000628)	(0.00120)	(0.00140)	(0.00120)	(0.000955)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Indicator of exposure:					
ER270b	-0.0995*	-0.0913***	0.00811	0.0584	0.0435	-0.0149
	(0.0491)	(0.0159)	(0.0367)	(0.0488)	(0.0425)	(0.0327)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Partial versus full exposure:					
P_HERend	0.000202	-3.29e-05	-0.000235	0.000154	0.000268	0.000114
	(0.000314)	(0.000233)	(0.000206)	(0.000321)	(0.000219)	(0.000267)
F_HER270b	-0.000262*	-0.000205***	5.69e-05	4.12e-05	5.61e-05	1.49e-05
	(0.000137)	(5.28e-05)	(0.000102)	(0.000121)	(0.000104)	(8.19e-05)
P_HERstart	-0.000559	-0.000452	0.000106	0.000465	0.000101	-0.000363
	(0.000390)	(0.000282)	(0.000293)	(0.000344)	(0.000253)	(0.000249)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103

Notes: Variables HER270b, DER270b, and ER270B contain hours, days, and indicator of exposure to Ramadan during the 270-day period before birth, respectively. F_HER270b contains hours of exposure for those who were exposed to a full 30-day Ramadan during the 270-day period, while P_HERstart and P_HERend contain hours of exposure for those who were partially exposed at the beginning and end of the 270-day period, respectively. Each coefficient (or the set of coefficients) is estimated in a regression for subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.3.3: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age at age 3 by sex and religion using different exposure measures

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Hours of exposure:					
HER190b	-0.000179	-2.48e-05	0.000154	6.81e-05	2.14e-05	-4.67e-05
	(0.000180)	(0.000130)	(0.000130)	(0.000228)	(8.97e-05)	(0.000205)
HER290b	3.05e-05	9.40e-05	6.36e-05	0.000153	2.21e-05	-0.000131
	(0.000224)	(0.000136)	(0.000188)	(0.000266)	(0.000132)	(0.000205)
HER390b	-0.000320*	-0.000264*	5.55e-05	0.000117	-9.19e-05	-0.000209
	(0.000177)	(0.000145)	(0.000151)	(0.000186)	(0.000136)	(0.000130)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Days of exposure:					
DER190b	-0.00235	-0.000426	0.00193	0.000931	0.000231	-0.000700
	(0.00213)	(0.00153)	(0.00156)	(0.00280)	(0.00109)	(0.00250)
DER290b	0.000477	0.00124	0.000765	0.00210	0.000457	-0.00165
	(0.00262)	(0.00157)	(0.00221)	(0.00322)	(0.00156)	(0.00251)
DER390b	-0.00395*	-0.00311*	0.000834	0.00147	-0.00103	-0.00250
	(0.00210)	(0.00169)	(0.00181)	(0.00224)	(0.00163)	(0.00155)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Indicator of exposure:					
ER190b	-0.0602	-0.0395	0.0207	0.0728	0.0462	-0.0266
	(0.0546)	(0.0363)	(0.0306)	(0.0465)	(0.0297)	(0.0433)
ER290b	-0.00714	0.00685	0.0140	0.0591	0.0139	-0.0452
	(0.0698)	(0.0330)	(0.0535)	(0.0518)	(0.0364)	(0.0407)
ER390b	-0.132**	-0.0967**	0.0351	0.0402	-0.0216	-0.0618*
	(0.0507)	(0.0361)	(0.0403)	(0.0401)	(0.0346)	(0.0333)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173
	Partial versus full exposure:					
P_HERend	0.000196	9.06e-05	-0.000106	0.00108***	0.00102***	-6.68e-05
	(0.000324)	(0.000156)	(0.000324)	(0.000358)	(0.000272)	(0.000194)
F_HER190b	-0.000219	-3.92e-05	0.000180	2.64e-05	-1.99e-05	-4.63e-05
	(0.000194)	(0.000135)	(0.000142)	(0.000228)	(8.63e-05)	(0.000216)
F_HER290b	2.92e-05	9.24e-05	6.33e-05	0.000211	7.86e-05	-0.000132
	(0.000228)	(0.000131)	(0.000195)	(0.000258)	(0.000127)	(0.000201)
F_HER390b	-0.000288	-0.000254*	3.41e-05	0.000157	-5.20e-05	-0.000209
	(0.000170)	(0.000145)	(0.000150)	(0.000189)	(0.000133)	(0.000128)
P_HERstart	-0.000637	-0.000382	0.000255	0.000414	0.000191	-0.000223
	(0.000422)	(0.000313)	(0.000289)	(0.000302)	(0.000200)	(0.000260)
Obs.	27,082	15,347	11,735	26,008	14,835	11,173

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Variables DER190b, DER290b, and DER390b contain days of and ER190b, ER290b, and ER390b are dummy variables for exposure to Ramadan during the trimesters. F_HER190b, F_HER290b, and F_HER390b contain hours exposure to Ramadan during the trimesters for those who were exposed to a full 30-day Ramadan during the three trimesters, while P_HERstart and P_HERend contain hours of exposure to Ramadan for those who were partially exposed at the beginning and end of the 270-day period, respectively. Each set of coefficients are estimated in a regression for subgroup of 3 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.3.4: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age at age 4 by sex and religion using different exposure measures

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Hours of exposure:					
HER190b	-0.000175	-6.98e-05	0.000105	9.61e-05	9.20e-05	-4.04e-06
	(0.000168)	(8.79e-05)	(0.000141)	(0.000205)	(0.000172)	(0.000118)
HER290b	-0.000445**	-0.000298***	0.000147	3.06e-05	4.62e-05	1.56e-05
	(0.000167)	(7.82e-05)	(0.000139)	(0.000141)	(9.98e-05)	(0.000108)
HER390b	-0.000249	-0.000273***	-2.37e-05	-2.95e-05	1.47e-05	4.41e-05
	(0.000216)	(9.76e-05)	(0.000156)	(0.000132)	(9.63e-05)	(0.000120)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Days of exposure:					
DER190b	-0.00243	-0.000980	0.00145	0.000970	0.000979	8.71e-06
	(0.00198)	(0.00105)	(0.00167)	(0.00246)	(0.00202)	(0.00142)
DER290b	-0.00546***	-0.00347***	0.00199	0.000433	0.000592	0.000158
	(0.00197)	(0.000881)	(0.00165)	(0.00171)	(0.00119)	(0.00130)
DER390b	-0.00315	-0.00323***	-7.88e-05	-0.000428	2.79e-05	0.000456
	(0.00252)	(0.00109)	(0.00188)	(0.00152)	(0.00110)	(0.00144)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Indicator of exposure:					
ER190b	-0.0459	-0.00667	0.0392	0.0798	0.0540	-0.0257
	(0.0490)	(0.0283)	(0.0371)	(0.0590)	(0.0573)	(0.0281)
ER290b	-0.115**	-0.0615***	0.0535	0.0160	0.0388*	0.0228
	(0.0429)	(0.0217)	(0.0339)	(0.0336)	(0.0194)	(0.0321)
ER390b	-0.0615	-0.0729***	-0.0113	0.0352	0.0442	0.00904
	(0.0567)	(0.0240)	(0.0416)	(0.0478)	(0.0318)	(0.0313)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103
	Partial versus full exposure:					
P_HERend	0.000176	-1.14e-05	-0.000188	0.000185	0.000277	9.21e-05
	(0.000332)	(0.000232)	(0.000238)	(0.000345)	(0.000220)	(0.000281)
F_HER190b	-0.000212	-8.66e-05	0.000125	0.000117	8.56e-05	-3.16e-05
	(0.000171)	(9.11e-05)	(0.000137)	(0.000215)	(0.000181)	(0.000119)
F_HER290b	-0.000447**	-0.000307***	0.000141	5.61e-05	5.86e-05	2.44e-06
	(0.000166)	(7.95e-05)	(0.000140)	(0.000141)	(9.90e-05)	(0.000106)
F_HER390b	-0.000218	-0.000259**	-4.12e-05	-4.20e-05	2.23e-05	6.42e-05
	(0.000206)	(0.000100)	(0.000146)	(0.000128)	(9.15e-05)	(0.000120)
P_HERstart	-0.000566	-0.000487*	7.83e-05	0.000435	8.99e-05	-0.000345
	(0.000414)	(0.000285)	(0.000323)	(0.000335)	(0.000252)	(0.000252)
Obs.	24,720	14,070	10,650	23,444	13,341	10,103

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Variables DER190b, DER290b, and DER390b contain days of and ER190b, ER290b, and ER390b are dummy variables for exposure to Ramadan during the trimesters. F_HER190b, F_HER290b, and F_HER390b contain hours exposure to Ramadan during the trimesters for those who were exposed to a full 30-day Ramadan during the three trimesters, while P_HERstart and P_HERend contain hours of exposure to Ramadan for those who were partially exposed at the beginning and end of the 270-day period, respectively. Each set of coefficients are estimated in a regression for subgroup of 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

D.4: Fixed-effect results

D.4.1: Effect of an hour of exposure to Ramadan during the 270-day period before birth on height-for-age Z-score by sex and religion

Measure of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Mothers' Fixed-Effect:					
HER270b	-0.000217	-0.000143	6.05e-05	0.000219	-2.60e-06	-0.000246**
	(0.000169)	(0.000117)	(0.000123)	(0.000165)	(0.000111)	(0.000121)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501
No. Mothers	137,142	72,924	64,342	131,601	69,905	61,796
	Households' Fixed-Effect:					
HER270b	-0.000156	-0.000123	1.74e-05	0.000203	3.02e-05	-0.000179
	(0.000155)	(0.000105)	(0.000114)	(0.000150)	(9.96e-05)	(0.000113)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501
No. Households	132,218	69,727	62,726	127,052	66,961	60,290
	OLS:					
HER270b	-1.35e-05	-3.08e-05	-1.74e-05	0.000196**	0.000121	-7.56e-05
	(6.18e-05)	(4.42e-05)	(5.72e-05)	(8.96e-05)	(8.19e-05)	(5.59e-05)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each coefficient is estimated in a regression for a subgroup of 0 to 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

D.4.2: Effect of an hour of exposure to Ramadan during three 90-day periods (trimesters) before birth on height-for-age Z-score by sex and religion

Measures of Exposure	Boys			Girls		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Mothers' Fixed-Effect:					
HER190b	-0.000249	-0.000210	4.36e-05	8.43e-05	-8.83e-05	-0.000187
	(0.000203)	(0.000140)	(0.000147)	(0.000197)	(0.000133)	(0.000146)
HER290b	-0.000439**	-0.000244*	0.000169	0.000410**	9.65e-05	-0.000344**
	(0.000207)	(0.000141)	(0.000152)	(0.000205)	(0.000137)	(0.000153)
HER390b	-2.85e-06	1.55e-05	-4.86e-08	0.000208	2.68e-06	-0.000235*
	(0.000205)	(0.000140)	(0.000150)	(0.000197)	(0.000137)	(0.000143)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501
No. Mothers	137,142	72,924	64,342	131,601	69,905	61,796
	Households' Fixed-Effect:					
HER190b	-0.000186	-0.000153	2.15e-05	0.000178	-2.19e-05	-0.000195
	(0.000186)	(0.000126)	(0.000138)	(0.000181)	(0.000119)	(0.000137)
HER290b	-0.000298	-0.000215*	6.28e-05	0.000323*	8.60e-05	-0.000250*
	(0.000189)	(0.000128)	(0.000140)	(0.000188)	(0.000123)	(0.000143)
HER390b	-6.02e-06	-1.32e-05	-1.89e-05	0.000136	3.59e-05	-0.000113
	(0.000187)	(0.000126)	(0.000138)	(0.000179)	(0.000122)	(0.000131)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501
No. Households	132,218	69,727	62,726	127,052	66,961	60,290
	OLS:					
HER190b	-9.22e-06	-3.37e-05	-2.45e-05	0.000129	4.75e-05	-8.18e-05
	(0.000106)	(6.03e-05)	(0.000109)	(0.000115)	(0.000101)	(8.97e-05)
HER290b	-1.43e-05	-1.60e-05	-1.76e-06	0.000168	0.000137	-3.06e-05
	(0.000104)	(8.44e-05)	(7.13e-05)	(0.000122)	(8.81e-05)	(9.31e-05)
HER390b	-2.05e-05	-4.10e-05	-2.05e-05	0.000281***	0.000181**	-9.92e-05***
	(5.28e-05)	(4.06e-05)	(3.70e-05)	(9.28e-05)	(8.36e-05)	(3.16e-05)
Obs.	157,386	84,264	73,122	151,493	80,992	70,501

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third trimester (90 days each) before birth. Each set of coefficients of the exposure measures are estimated in a regression for subgroup of 0 to 4 years old children specified by sex and mother's religion. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

D.5: Inclusion of pre-birth exposure measures

Table D.5.1: Effect of an hour of exposure to Ramadan during the first to eighteenth 30-day periods (months) before birth on 4-year-old male children's height-for-age Z-score when only Muslims are included

Exposure	Regressions when exposure measures in the following months are included:									
Measures	1–9	1–10	1–11	1–12	1–13	1–14	1–15	1–16	1–17	1–18
HER130b	-8.37e-05	-0.000332**	-0.000118	0.000953	0.000953	0.000291	-2.64e-06	-0.000278	0.000411	0.000424
	(0.000138)	(0.000126)	(0.000266)	(0.000871)	(0.000871)	(0.00104)	(0.00134)	(0.00124)	(0.00121)	(0.00119)
HER230b	-4.49e-05	-0.000217	-5.60e-05	0.00122	0.00122	0.00154	0.000898	0.000201	0.00202	0.00206
	(0.000119)	(0.000130)	(0.000169)	(0.000971)	(0.000971)	(0.00128)	(0.00187)	(0.00191)	(0.00188)	(0.00177)
HER330b	-0.000121	-0.000310	-0.000137	0.00109	0.00109	0.00264**	0.00205	0.00107	0.00397*	0.00404*
	(0.000184)	(0.000201)	(0.000279)	(0.000899)	(0.000899)	(0.00122)	(0.00179)	(0.00219)	(0.00214)	(0.00199)
HER430b	-0.000252***	-0.000457***	-0.000285*	0.000956	0.000956	0.00264*	0.00273**	0.00198	0.00524***	0.00532***
	(8.71e-05)	(0.000112)	(0.000155)	(0.000961)	(0.000961)	(0.00132)	(0.00131)	(0.00161)	(0.00190)	(0.00178)
HER530b	-0.000316*	-0.000520**	-0.000341	0.000906	0.000906	0.00258*	0.00279**	0.00283**	0.00508***	0.00516***
	(0.000177)	(0.000241)	(0.000280)	(0.000955)	(0.000955)	(0.00133)	(0.00135)	(0.00138)	(0.00131)	(0.00169)
HER630b	-0.000312**	-0.000520***	-0.000346*	0.000902	0.000902	0.00258*	0.00276**	0.00293**	0.00283**	0.00289
	(0.000147)	(0.000126)	(0.000200)	(0.000995)	(0.000995)	(0.00130)	(0.00130)	(0.00141)	(0.00137)	(0.00186)
HER730b	-0.000458**	-0.000676***	-0.000498	0.000751	0.000751	0.00243*	0.00261*	0.00276*	0.00226	0.00226
	(0.000207)	(0.000226)	(0.000337)	(0.00101)	(0.00101)	(0.00134)	(0.00132)	(0.00141)	(0.00148)	(0.00147)
HER830b	-6.63e-05	-0.000303*	-0.000125	0.00112	0.00112	0.00280**	0.00298**	0.00314**	0.00274*	0.00274*
	(0.000134)	(0.000155)	(0.000213)	(0.000981)	(0.000981)	(0.00133)	(0.00132)	(0.00140)	(0.00143)	(0.00138)
HER930b	-0.000377**	-0.000497***	-0.000313	0.000937	0.000937	0.00260**	0.00279**	0.00293**	0.00252*	0.00251*
	(0.000175)	(0.000171)	(0.000247)	(0.000960)	(0.000960)	(0.00124)	(0.00125)	(0.00135)	(0.00138)	(0.00134)
HER1030b		-0.000579**	-0.000437*	0.000801	0.000801	0.00247*	0.00266**	0.00280**	0.00240*	0.00239*
		(0.000247)	(0.000250)	(0.000845)	(0.000845)	(0.00125)	(0.00127)	(0.00134)	(0.00137)	(0.00133)
HER1130b			0.000310	0.00158	0.00158	0.00321**	0.00338**	0.00352**	0.00314**	0.00313**
			(0.000286)	(0.00107)	(0.00107)	(0.00133)	(0.00131)	(0.00140)	(0.00142)	(0.00139)
HER1230b				0.00113	0.00113	0.00291**	0.00312**	0.00329**	0.00284*	0.00283**
				(0.000841)	(0.000841)	(0.00126)	(0.00130)	(0.00138)	(0.00141)	(0.00137)
HER1330b						0.00229*	0.00284	0.00333*	0.00206	0.00204
						(0.00127)	(0.00171)	(0.00175)	(0.00188)	(0.00176)
HER1430b						0.00105	0.00190	0.00282	0.000377	0.000329
						(0.000915)	(0.00178)	(0.00215)	(0.00241)	(0.00216)
HER1530b							0.000679	0.00181	-0.00163	-0.00171
							(0.00130)	(0.00223)	(0.00267)	(0.00232)
HER1630b								0.000781	-0.00283	-0.00292
								(0.00124)	(0.00226)	(0.00190)
HER1730b									-0.00229**	-0.00238*
									(0.00112)	(0.00130)
HER1830b										-5.36e-05
										(0.000833)
Obs.	14,070	14,070	14,070	14,070	14,070	14,070	14,070	14,070	14,070	14,070

Notes: Variables HER130b, HER230b, ... , and HER1830b contain hours of exposure to Ramadan during the first, second, ... , and eighteenth 30-day periods (months) before birth. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table D.5.1: Effect of an hour of exposure to Ramadan during the first to eighteenth 30-day periods (months) before birth on 4-year-old male children's height-for-age Z-score when both Muslims and non-Muslims are included

Exposure	Regressions when exposure measures in the following months are included:									
Measures	1–9	1–10	1–11	1–12	1–13	1–14	1–15	1–16	1–17	1–18
HER130b	-7.07e-05	-0.000314	-8.53e-05	0.00269	0.00252	0.00170	0.00155	0.000711	0.00105	0.000822
	(0.000254)	(0.000245)	(0.000340)	(0.00173)	(0.00167)	(0.00185)	(0.00200)	(0.00202)	(0.00217)	(0.00224)
HER230b	-0.000256	-0.000424**	-0.000252	0.00306	0.00401*	0.00490	0.00456	0.00244	0.00332	0.00267
	(0.000189)	(0.000185)	(0.000299)	(0.00208)	(0.00220)	(0.00295)	(0.00321)	(0.00352)	(0.00405)	(0.00424)
HER330b	-0.000188	-0.000373	-0.000188	0.00299	0.00417**	0.00787**	0.00752**	0.00463	0.00604	0.00496
	(0.000314)	(0.000333)	(0.000352)	(0.00183)	(0.00202)	(0.00303)	(0.00325)	(0.00385)	(0.00471)	(0.00488)
HER430b	-0.000730***	-0.000931***	-0.000746**	0.00248	0.00359	0.00769**	0.00765**	0.00551	0.00710	0.00570
	(0.000211)	(0.000246)	(0.000357)	(0.00203)	(0.00219)	(0.00330)	(0.00344)	(0.00335)	(0.00428)	(0.00478)
HER530b	-0.000231	-0.000430	-0.000240	0.00299	0.00413*	0.00814**	0.00815**	0.00851**	0.00964**	0.00824
	(0.000301)	(0.000333)	(0.000420)	(0.00194)	(0.00214)	(0.00320)	(0.00347)	(0.00352)	(0.00372)	(0.00499)
HER630b	-0.000413*	-0.000617***	-0.000431	0.00279	0.00393*	0.00796**	0.00796**	0.00873**	0.00877**	0.00788*
	(0.000211)	(0.000203)	(0.000283)	(0.00202)	(0.00218)	(0.00326)	(0.00350)	(0.00370)	(0.00374)	(0.00441)
HER730b	-0.000374	-0.000587*	-0.000397	0.00283	0.00397*	0.00800**	0.00800**	0.00867**	0.00851**	0.00861**
	(0.000310)	(0.000332)	(0.000438)	(0.00191)	(0.00209)	(0.00321)	(0.00342)	(0.00359)	(0.00371)	(0.00374)
HER830b	9.15e-05	-0.000139	5.08e-05	0.00328	0.00442*	0.00845**	0.00845**	0.00915**	0.00905**	0.00929**
	(0.000317)	(0.000318)	(0.000358)	(0.00206)	(0.00222)	(0.00330)	(0.00355)	(0.00373)	(0.00382)	(0.00388)
HER930b	-0.000540*	-0.000657**	-0.000461	0.00277	0.00391*	0.00793**	0.00794**	0.00862**	0.00851**	0.00872**
	(0.000271)	(0.000277)	(0.000353)	(0.00199)	(0.00212)	(0.00324)	(0.00348)	(0.00365)	(0.00375)	(0.00380)
HER1030b		-0.000565*	-0.000413	0.00279	0.00393*	0.00796**	0.00796**	0.00865**	0.00855**	0.00876**
		(0.000299)	(0.000363)	(0.00191)	(0.00211)	(0.00321)	(0.00345)	(0.00359)	(0.00369)	(0.00376)
HER1130b			0.000332	0.00363*	0.00474**	0.00872**	0.00872**	0.00937**	0.00928**	0.00949**
			(0.000389)	(0.00214)	(0.00229)	(0.00337)	(0.00356)	(0.00371)	(0.00380)	(0.00385)
HER1230b				0.00292	0.00411**	0.00828**	0.00830**	0.00906**	0.00894**	0.00917**
				(0.00179)	(0.00197)	(0.00317)	(0.00346)	(0.00365)	(0.00376)	(0.00383)
HER1330b					0.00118	0.00595**	0.00615*	0.00790**	0.00738*	0.00789*
					(0.000730)	(0.00233)	(0.00310)	(0.00363)	(0.00408)	(0.00433)
HER1430b						0.00255	0.00292	0.00593	0.00485	0.00579
						(0.00155)	(0.00293)	(0.00424)	(0.00520)	(0.00560)
HER1530b							0.000315	0.00390	0.00231	0.00369
							(0.00202)	(0.00405)	(0.00544)	(0.00589)
HER1630b								0.00245	0.000774	0.00242
								(0.00199)	(0.00396)	(0.00506)
HER1730b									-0.00107	0.000498
									(0.00183)	(0.00443)
HER1830b										0.000943
										(0.00245)
Obs.	24,720	24,720	24,720	24,720	24,720	24,720	24,720	24,720	24,720	24,720

Notes: Variables HER130b, HER230b, ... , and HER1830b contain hours of exposure to Ramadan during the first, second, ... , and eighteenth 30-day periods (months) before birth. Control variables in the regressions are children's age in days, children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Appendix E:
Results of regressions in which correlates of the length of gestation are dependent variable

E.1: Birthweight

Table E.1.1: Effect of an hour of exposure to Ramadan during the 270-day and three 90-day periods before birth on children's birthweight (kg) by method of estimation, sex, and religion

Measures of Exposure	OLS			Mother's Fixed-Effect		
	All	Muslims	Non-Muslims	All	Muslims	Non-Muslims
	Panel A: male children					
HER270b	-3.36e-05	-1.61e-06	3.20e-05	-6.63e-05	8.01e-06	7.15e-05
	(3.37e-05)	(1.76e-05)	(2.52e-05)	(9.03e-05)	(5.92e-05)	(6.84e-05)
HER190b	-3.09e-05	-9.11e-06	2.18e-05	-0.000107	1.86e-05	0.000127
	(4.15e-05)	(2.63e-05)	(2.76e-05)	(0.000109)	(7.12e-05)	(8.28e-05)
HER290b	-6.36e-05*	-1.38e-05	4.98e-05*	-8.81e-05	-5.75e-06	7.97e-05
	(3.25e-05)	(1.94e-05)	(2.87e-05)	(0.000112)	(7.08e-05)	(8.71e-05)
HER390b	-1.45e-05	1.77e-05	3.22e-05	-9.07e-06	1.27e-05	1.73e-05
	(4.74e-05)	(2.57e-05)	(3.62e-05)	(0.000110)	(7.53e-05)	(8.02e-05)
Obs.	80,868	38,889	41,979	80,868	38,889	41,979
No. Mothers	–	–	–	72,748	34,626	38,163
	Panel B: female children					
HER270b	-3.11e-05	-1.96e-05	1.16e-05	-6.82e-05	3.77e-05	0.000110*
	(4.00e-05)	(1.84e-05)	(3.20e-05)	(8.59e-05)	(5.98e-05)	(6.16e-05)
HER190b	-1.06e-05	-1.59e-05	-5.32e-06	1.49e-05	3.97e-05	2.43e-05
	(4.80e-05)	(2.32e-05)	(3.81e-05)	(0.000103)	(7.18e-05)	(7.47e-05)
HER290b	-1.20e-07	-2.94e-05	-2.93e-05	-8.64e-05	8.83e-06	0.000104
	(4.15e-05)	(2.28e-05)	(3.44e-05)	(0.000111)	(7.51e-05)	(8.23e-05)
HER390b	-6.50e-05	-1.41e-05	5.09e-05	-0.000131	6.39e-05	0.000199***
	(4.17e-05)	(2.11e-05)	(3.39e-05)	(0.000108)	(7.50e-05)	(7.69e-05)
Obs.	76,225	36,411	39,814	76,225	36,411	39,814
No. Mohers	–	–	–	68,396	32,337	36,086

Notes: Results of two series of specifications of regressions are presented in this table. In one series of specification, HER270b—hours of exposure to Ramadan during the 270-day period before birth—is used as the exposure measure. In another series of specification, HER190b, HER290b, and HER390b—hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth, respectively—are used as the exposure measures. In all of the regressions, the dependent variable is currently alive children's birthweight in kilograms. Each coefficient (or set of coefficients) is estimated in a regression for a subgroup of children specified by their mother's religion. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. The regressions that use both Muslims' and non-Muslims' information (their results are reported under "All") contain the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.1.2: Muslim-nonMuslim differential effect of an hour exposure to Ramadan during 30-day periods (months) before birth on male children's birthweight (kg)

Exposure	OLS				Mother's Fixed-Effect			
Measures	7 months	8 months	9 months	10 months	7 months	8 months	9 months	10 months
HER130b	*-0.000101**	*-9.83e-05*	*-0.000107*	*-4.64e-05*	*-0.000292**	*-0.000271**	*-0.000271*	*-0.000242*
	(5.72e-05)	*(5.92e-05)*	*(6.53e-05)*	*(8.01e-05)*	*(0.000161)*	*(0.000164)*	*(0.000171)*	*(0.000188)*
HER230b	1.90e-05	2.18e-05	1.55e-05	5.86e-05	-4.05e-05	-2.29e-05	-2.44e-05	-4.27e-06
	(5.12e-05)	(4.88e-05)	(4.98e-05)	(4.98e-05)	(0.000155)	(0.000157)	(0.000162)	(0.000169)
HER330b	-2.12e-05	-1.94e-05	-2.68e-05	2.18e-05	-9.68e-05	-7.12e-05	-7.28e-05	-4.81e-05
	(5.48e-05)	(5.32e-05)	(6.21e-05)	(6.88e-05)	(0.000162)	(0.000165)	(0.000170)	(0.000183)
HER430b	-5.66e-05	-5.60e-05	-6.38e-05	-1.47e-05	-0.000148	-0.000121	-0.000125	-0.000102
	(7.97e-05)	(8.18e-05)	(8.28e-05)	(9.47e-05)	(0.000159)	(0.000161)	(0.000167)	(0.000178)
HER530b	*-0.000101*	*-0.000101*	*-0.000109*	*-5.83e-05*	-7.40e-05	-4.40e-05	-4.83e-05	-2.41e-05
	(7.14e-05)	*(6.98e-05)*	*(6.71e-05)*	*(7.96e-05)*	(0.000161)	(0.000165)	(0.000171)	(0.000182)
HER630b	-6.38e-06	-5.32e-06	-1.36e-05	3.96e-05	-0.000136	-9.76e-05	-0.000103	-7.69e-05
	(6.05e-05)	(5.78e-05)	(6.40e-05)	(6.34e-05)	(0.000158)	(0.000164)	(0.000170)	(0.000183)
HER730b	-2.89e-05	-3.01e-05	-4.08e-05	1.18e-05	*-0.000201*	*-0.000193*	*-0.000196*	*-0.000169*
	(4.85e-05)	(4.84e-05)	(4.52e-05)	(5.88e-05)	*(0.000161)*	*(0.000161)*	*(0.000170)*	*(0.000184)*
HER830b		1.00e-05	7.50e-06	6.89e-05		0.000125	0.000121	0.000152
		(7.40e-05)	(7.61e-05)	(9.35e-05)		(0.000161)	(0.000162)	(0.000178)
HER930b			-3.28e-05	-4.58e-06			-3.95e-06	8.75e-06
			(6.77e-05)	(7.28e-05)			(0.000165)	(0.000168)
HER1030b				0.000150*				7.29e-05
				(8.26e-05)				(0.000184)
Obs.	80,868	80,868	80,868	80,868	80,868	80,868	80,868	80,868
No. Mothers	–	–	–	–	72,748	72,748	72,748	72,748

Notes: In each column, estimated coefficients of the exposure measure in one of the regressions are reported. The exposure measures are variables HER130b, HER230b, ... , HER930b, and HER1030b: hours of exposure to Ramadan during the first, second, ... , ninth, and tenth 30-day periods (months) before birth. In all of the regressions, the dependent variable is currently alive children's birthweight in kilograms and control variables are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. All regressions use both Muslims' and non-Muslims' information, and the full set of interaction terms in which Muslim dummy is interacted with all of the explanatory variables. The sets of coefficients that are highlighted by Italic font depict a pattern across regressions. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

E.2: Neonatal mortality

Table E.2.1: Muslim-nonMuslim differential effect of an hour exposure to Ramadan on the likelihood of a male child's death in the first day and month after birth

Panel A: Dependent variable is a dummy that takes 1 if a child died in the first day

	OLS			Fixed-effect		
	Assumed Gestation Length			Assumed Gestation Length		
Exposure measures:↓	9 months	8 months	7 months	9 months	8 months	7 months
Possible Exposure in Birth Month	1.51e-05	6.93e-06	9.06e-06	1.32e-05	1.41e-06	-1.06e-05
	(1.18e-05)	(1.21e-05)	(1.15e-05)	(3.43e-05)	(2.27e-05)	(2.59e-05)
More Likely Exposure in Middle Months	1.72e-06	-4.22e-06	-3.85e-06	-2.51e-05	-5.50e-06	1.96e-05
	(7.42e-06)	(7.72e-06)	(7.58e-06)	(2.00e-05)	(1.34e-05)	(1.49e-05)
Possible Exposure in Conception Month	2.02e-05**	-7.48e-06	7.61e-06	-1.58e-05	-2.87e-06	1.42e-05
	(9.27e-06)	(1.15e-05)	(1.07e-05)	(3.31e-05)	(2.25e-05)	(2.45e-05)
Number of deceased children	9,898	9,898	9,898	9,898	9,898	9,898
Number of alive children	250,305	250,305	250,305	250,305	250,305	250,305
No. Mothers	–	–	–	217,691	115,470	102,414

Panel B: Dependent variable is a dummy that takes 1 if a child died in the first month

	OLS			Fixed-effect		
	Assumed Gestation Length			Assumed Gestation Length		
Exposure measures:↓	9 months	8 months	7 months	9 months	8 months	7 months
Possible Exposure in Birth Month	1.26e-05	1.54e-06	3.65e-06	-2.09e-05	2.88e-08	2.26e-05
	(1.19e-05)	(1.24e-05)	(1.19e-05)	(3.60e-05)	(2.36e-05)	(2.73e-05)
More Likely Exposure in Middle Months	4.37e-06	-3.74e-06	-3.68e-06	-2.51e-05	1.51e-07	2.50e-05
	(7.69e-06)	(8.41e-06)	(8.63e-06)	(2.10e-05)	(1.41e-05)	(1.56e-05)
Possible Exposure in Conception Month	2.72e-05**	-7.36e-06	1.01e-05	-1.05e-05	1.36e-05	2.47e-05
	(1.14e-05)	(1.10e-05)	(1.12e-05)	(3.49e-05)	(2.36e-05)	(2.58e-05)
Number of deceased children	11,101	11,101	11,101	11,101	11,101	11,101
Number of alive children	250,305	250,305	250,305	250,305	250,305	250,305
No. Mothers	–	–	–	218,380	115,823	102,752

Notes: Each entry of the table shows the association of the likelihood of a male child's death in the first day or month after birth with a an hour of exposure to Ramadan in the corresponding episode of gestation (specified in the first column) if gestation lengths is presumed to be what is specified in the top rows. In each panel, results of estimating linear probability models with two method, OLS and fixed-effect, are presented. Three scenarios of length of gestation are examined: 9, 8, and 7 months gestations. Control variables are year of birth, month of birth, an indicator for urban/rural, an indicator of country and province of residence, mother's height, mother's age at birth, father's age at birth, mother's education level, father's education level, and an indicator of household's wealth. Standard deviations are clustered at country level. Sings *, **, and *** show statistical significance at 10%, 5%, and 1% levels, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.2.2: Muslim-nonMuslim differential effect of an hour exposure to Ramadan on the likelihood of a female child's death in the first day and month after birth

Panel A: Dependent variable is a dummy that takes 1 if a child died in the first day						
	OLS			Fixed-effect		
	Assumed Gestation Length			Assumed Gestation Length		
Exposure measures:↓	9 months	8 months	7 months	9 months	8 months	7 months
Possible Exposure in Birth Month	2.85e-06	2.69e-06	5.28e-06	-3.09e-05	-4.93e-06	2.93e-05
	(1.13e-05)	(8.83e-06)	(8.42e-06)	(3.10e-05)	(2.06e-05)	(2.30e-05)
More Likely Exposure in Middle Months	-1.17e-05**	-1.21e-05***	-1.15e-05***	-2.75e-05	-4.20e-06	2.32e-05*
	(5.67e-06)	(3.96e-06)	(3.39e-06)	(1.84e-05)	(1.23e-05)	(1.37e-05)
Possible Exposure in Conception Month	6.26e-07	-1.01e-05	1.01e-06	-3.62e-05	-2.25e-05	1.39e-05
	(1.21e-05)	(9.32e-06)	(5.90e-06)	(3.11e-05)	(2.07e-05)	(2.33e-05)
	(9.27e-06)	(1.15e-05)	(1.07e-05)	(3.31e-05)	(2.25e-05)	(2.45e-05)
Number of deceased children	7,389	7,389	7,389	7,389	7,389	7,389
Number of alive children	241,923	241,923	241,923	241,923	241,923	241,923
No. Mothers	–	–	–	208,306	110,377	98,105
Panel B: Dependent variable is a dummy that takes 1 if a child died in the first month						
	OLS			Fixed-effect		
	Assumed Gestation Length			Assumed Gestation Length		
Exposure measures:↓	9 months	8 months	7 months	9 months	8 months	7 months
Possible Exposure in Birth Month	4.68e-06	4.56e-06	7.90e-06	-1.47e-05	-6.53e-07	1.84e-05
	(1.02e-05)	(8.13e-06)	(7.57e-06)	(3.29e-05)	(2.20e-05)	(2.43e-05)
More Likely Exposure in Middle Months	-1.00e-05*	-9.75e-06**	-8.39e-06**	-1.59e-05	3.81e-06	1.99e-05
	(5.56e-06)	(3.65e-06)	(3.41e-06)	(1.94e-05)	(1.30e-05)	(1.45e-05)
Possible Exposure in Conception Month	-4.39e-08	-1.28e-05	3.20e-06	-4.81e-05	-3.05e-05	1.82e-05
	(1.14e-05)	(9.93e-06)	(7.68e-06)	(3.29e-05)	(2.20e-05)	(2.48e-05)
Number of deceased children	8,397	8,397	8,397	8,397	8,397	8,397
Number of alive children	241,923	241,923	241,923	241,923	241,923	241,923
No. Mothers	–	–	–	208,859	110,658	98,379

Notes: Each entry of the table shows the association of the likelihood of a male child's death in the first day or month after birth with a an hour of exposure to Ramadan in the corresponding episode of gestation (specified in the first column) if gestation lengths is presumed to be what is specified in the top rows. In each panel, results of estimating linear probability models with two method, OLS and fixed-effect, are presented. Three scenarios of length of gestation are examined: 9, 8, and 7 months gestations. Control variables are year of birth, month of birth, an indicator for urban/rural, an indicator of country and province of residence, mother's height, mother's age at birth, father's age at birth, mother's education level, father's education level, and an indicator of household's wealth. Standard deviations are clustered at country level. Sings *, **, and *** show statistical significance at 10%, 5%, and 1% levels, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

D.3: Breastfeeding

Table E.3.1: Muslim-nonMuslim differential effect of an hour exposure to Ramadan during the 270-day period before birth on the likelihood of breastfeeding and breastfeeding initiation

Panel A: Linear probability models estimated using OLS method										
Exposure	Dependent variables (Y) for boys					Dependent variables (Y) for girls				
Measure:↓	EVER	DAYS	DAY1	HOUR1	HOUR0	EVER	DAYS	DAY1	HOUR1	HOUR0
HER270b	6.29e-06	-2.26e-05	8.90e-06	9.30e-06	9.26e-06	2.55e-06	1.40e-05	4.53e-06	4.19e-06	4.90e-06
	(4.79e-06)	(4.24e-05)	(6.46e-06)	(1.25e-05)	(1.32e-05)	(5.80e-06)	(2.33e-05)	(7.62e-06)	(1.43e-05)	(1.67e-05)
Obs. if Y=0	4002		4002	4002	4002	3688		3688	3688	3688
Obs. if Y=1	190469	160,533	139200	70495	61605	182440	152,042	132736	68121	59528
Panel B: Linear probability models estimated using fixed-effect method										
Exposure	Dependent variables (Y) for boys					Dependent variables (Y) for girls				
Measure:↓	EVER	DAYS	DAY1	HOUR1	HOUR0	EVER	DAYS	DAY1	HOUR1	HOUR0
HER270b	7.87e-06	6.16e-05	-1.34e-05	-1.64e-05	-1.91e-05	-1.63e-05	0.000259	-3.12e-05	-6.83e-05*	-6.03e-05
	(1.28e-05)	(0.000113)	(2.94e-05)	(4.81e-05)	(5.30e-05)	(1.22e-05)	(0.000189)	(2.55e-05)	(4.03e-05)	(4.38e-05)
Obs.	194,471		143,202	74,497	65,607	186,128		136,424	71,809	63,216
No. mothers	169,279	160,533	133,206	70,073	61,644	161,724	152,042	126,667	67,371	59,285

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each estimated coefficient times 360 is the association of dependent variables specified in the top rows with exposure to a full month of Ramadan during the 270-day period before birth for a currently alive male or female child. The dependent variables are ever being breastfed (EVER), the day number after birth when a child was put to breast (DAYS), if a child was put to breast in day 1 after birth versus never being breastfed (DAY1), if a child was put to breast in hour 1 after birth versus never being breastfed (HOUR1), and if a child was put to breast immediately after birth versus never being breastfed (HOUR0). Linear probability models are estimated when a dependent variable is a dummy variable. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.2: Muslim-nonMuslim differential effect of an hour exposure to Ramadan during three 90-day periods (trimesters) before birth on the likelihood of breastfeeding and breastfeeding initiation

Panel A: Linear probability models estimated using OLS method

Exposure	Dependent variables (Y) for boys					Dependent variables (Y) for girls				
Measures:↓	EVER	DAYS	DAY1	HOUR1	HOUR0	EVER	DAYS	DAY1	HOUR1	HOUR0
HER190b	5.52e-06	-6.88e-05	8.96e-06	7.99e-06	7.92e-06	1.88e-06	-1.13e-06	3.62e-06	4.21e-06	2.42e-06
	(5.81e-06)	(5.92e-05)	(6.97e-06)	(1.09e-05)	(1.29e-05)	(6.09e-06)	(2.74e-05)	(7.85e-06)	(1.49e-05)	(1.74e-05)
HER290b	1.14e-05**	6.16e-05	1.65e-05**	2.51e-05	2.76e-05	-1.23e-06	1.33e-06	-1.34e-07	-7.81e-06	-6.74e-06
	(5.54e-06)	(4.18e-05)	(7.62e-06)	(1.54e-05)	(1.66e-05)	(6.75e-06)	(3.65e-05)	(9.30e-06)	(1.74e-05)	(1.97e-05)
HER390b	2.94e-06	-4.04e-05	2.01e-06	-2.48e-06	-4.99e-06	6.42e-06	3.42e-05	9.38e-06	1.32e-05	1.63e-05
	(7.11e-06)	(4.84e-05)	(1.01e-05)	(2.02e-05)	(2.14e-05)	(7.24e-06)	(3.52e-05)	(1.00e-05)	(1.89e-05)	(2.18e-05)
Obs. if Y=0	4002	160,533	4002	4002	4002	3688	152,042	3688	3688	3688
Obs. if Y=1	190469		139200	70495	61605	182440		132736	68121	59528

Panel B: Linear probability models estimated using fixed-effect method

Exposure	Dependent variables (Y) for boys					Dependent variables (Y) for girls				
Measures:↓	EVER	DAYS	DAY1	HOUR1	HOUR0	EVER	DAYS	DAY1	HOUR1	HOUR0
HER190b	-6.01e-06	-8.98e-05	6.62e-05**	0.000101**	0.000102**	1.87e-05*	-0.000117	7.06e-05***	7.54e-05**	7.05e-05*
	(1.13e-05)	(8.31e-05)	(2.69e-05)	(4.07e-05)	(4.60e-05)	(1.06e-05)	(0.000138)	(2.21e-05)	(3.41e-05)	(3.79e-05)
HER290b	1.22e-06	4.15e-05	3.22e-05	2.67e-05	2.29e-05	3.48e-06	-1.30e-05	1.73e-05	-1.75e-06	-1.33e-05
	(1.14e-05)	(8.18e-05)	(2.84e-05)	(4.32e-05)	(4.83e-05)	(1.14e-05)	(0.000111)	(2.54e-05)	(3.80e-05)	(4.27e-05)
HER390b	3.43e-06	-4.74e-05	1.21e-05	8.54e-06	4.59e-06	5.20e-06	-0.000196	2.89e-05	2.11e-05	4.95e-06
	(1.07e-05)	(7.02e-05)	(2.44e-05)	(3.73e-05)	(4.21e-05)	(1.04e-05)	(0.000133)	(2.10e-05)	(3.03e-05)	(3.42e-05)
Obs.	194,471	160,533	143,202	74,497	65,607	186,128	152,042	136,424	71,809	63,216
No. Mothers	169,279		133,206	70,073	61,644	161,724		126,667	67,371	59,285

Notes: Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each estimated coefficient times 360 shows the association of dependent variables specified in the top rows with exposure to a full month of Ramadan during the 270-day period before birth for a currently alive male or female child. The dependent variables are ever being breastfed (EVER), the day number after birth when a child was put to breast (DAYS), if a child was put to breast in day 1 after birth versus never being breastfed (DAY1), if a child was put to breast in hour 1 after birth versus never being breastfed (HOUR1), and if a child was put to breast immediately after birth versus never being breastfed (HOUR0). Linear probability models are estimated when a dependent variable is a dummy variable. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.3: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a male child being breastfed for at least 3, 4, . . . , or 9 months (OLS regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

	Case 1: Never-breastfed children are included:							
Exposure Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	1.35e-05	1.96e-05	2.24e-05	2.04e-05	2.63e-05	2.55e-05*	1.75e-05
	-	(1.02e-05)	(1.25e-05)	(1.47e-05)	(1.54e-05)	(1.71e-05)	(1.48e-05)	(1.25e-05)
No. breastfed < i months	-	5933	6871	7503	8034	9295	9912	10892
No. breastfed ≥ months	-	142895	137731	132880	128193	122836	118293	113507
	Case 2: Never-breastfed children are excluded:							
Exposure Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	5.47e-06	1.11e-05	1.35e-05	1.29e-05	1.79e-05	1.69e-05	7.25e-06
	-	(5.93e-06)	(7.82e-06)	(9.98e-06)	(1.09e-05)	(1.29e-05)	(1.25e-05)	(1.17e-05)
No. breastfed < i months	-	2,032	3,012	3,690	4,259	5,568	6,222	7,248
No. breastfed ≥ months	-	142,895	137,731	132,880	128,193	122,836	118,293	113,507

Panel B: Only ever-breastfed children are included:

	Case 1: Never-breastfed children are included:							
Exposure Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000839*	2.09e-05	2.57e-05	2.65e-05	2.18e-05	3.14e-05	3.07e-05	1.86e-05
	(0.000452)	(1.74e-05)	(2.11e-05)	(2.33e-05)	(2.22e-05)	(2.69e-05)	(2.69e-05)	(2.54e-05)
No. breastfed < i months	77,180	6,153	7,176	7,916	8,569	9,977	10,726	11,880
No. breastfed ≥ i months		70,615	69,592	68,852	68,199	66,791	66,042	64,888
	Case 2: Never-breastfed children are excluded:							
Exposure Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000583	7.48e-06	1.23e-05	1.37e-05	9.15e-06	2.03e-05	2.02e-05	7.43e-06
	(0.000472)	(1.54e-05)	(1.89e-05)	(2.16e-05)	(2.04e-05)	(2.65e-05)	(2.84e-05)	(2.79e-05)
No. breastfed < i months	72,680	2,094	3,117	3,857	4,510	5,918	6,667	7,821
No. breastfed ≥ i months		70,615	69,592	68,852	68,199	66,791	66,042	64,888

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=3,4,...,9) times 360 is the estimated association of the likelihood of being breastfed for at least 3, 4, ... , 9 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated by the OLS method in these cases. Each entry under "months"times 360 is the OLS estimated association of months breastfed with exposure to a full month of Ramadan during the 270-day period before birth. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.3 (continued): Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a male child being breastfed for at least 10, 11, . . . , or 16 months (OLS regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

	Case 1: Never-breastfed children are included:						
Exposure Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	1.35e-05	1.04e-05	4.75e-06	-1.17e-05	-1.66e-05	-1.25e-05	7.03e-07
	(1.25e-05)	(1.31e-05)	(1.35e-05)	(1.37e-05)	(1.39e-05)	(1.44e-05)	(1.61e-05)
No. breastfed < i months	12,253	13,168	13,694	20,398	21,343	23,509	25,740
No. breastfed ≥ i months	108,500	104,100	99,526	88,888	84,163	78,373	72,582
	Case 2: Never-breastfed children are excluded:						
Exposure Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	3.38e-06	1.04e-06	-4.54e-06	-2.15e-05	-2.70e-05*	-2.35e-05	-1.24e-05
	(1.30e-05)	(1.23e-05)	(1.27e-05)	(1.44e-05)	(1.49e-05)	(1.56e-05)	(1.73e-05)
No. breastfed < i months	8,646	9,596	10,168	16,909	17,909	20,118	22,391
No. breastfed ≥ i months	108,500	104,100	99,526	88,888	84,163	78,373	72,582

Panel B: Only ever-breastfed children are included:

	Case 1: Never-breastfed children are included:						
Exposure Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	1.11e-05	8.57e-06	4.97e-06	-1.22e-05	-1.93e-05	-3.44e-06	4.17e-06
	(2.50e-05)	(2.44e-05)	(2.48e-05)	(2.18e-05)	(2.12e-05)	(2.00e-05)	(2.35e-05)
No. breastfed < i months	13,427	14,539	15,336	22,403	23,737	26,328	29,072
No. breastfed ≥ i months	63,341	62,229	61,432	54,365	53,031	50,440	47,696
	Case 2: Never-breastfed children are excluded:						
Exposure Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	-5.65e-08	-2.59e-06	-6.80e-06	-2.27e-05	-3.01e-05	-1.20e-05	-2.44e-06
	(2.76e-05)	(2.62e-05)	(2.68e-05)	(2.51e-05)	(2.43e-05)	(2.20e-05)	(2.38e-05)
No. breastfed < i months	9,368	10,480	11,277	18,344	19,678	22,269	25,013
No. breastfed ≥ i months	63,341	62,229	61,432	54,365	53,031	50,440	47,696

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=10,11,...,16) times 360 is the estimated association of the likelihood of being breastfed for at least 10, 11, ... , 16 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated by the OLS method in these cases. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.4: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a male child being breastfed for at least 3, 4, . . . , or 9 months (mothers' fixed-effect regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	4.19e-08	2.06e-05	3.58e-05	2.57e-05	1.14e-06	-8.29e-06	-2.85e-05
	-	(2.30e-05)	(2.47e-05)	(2.64e-05)	(2.82e-05)	(3.09e-05)	(3.42e-05)	(3.86e-05)
Obs.	-	148,828	144,602	140,383	136,227	132,131	128,205	124,399
No. Mothers	-	133,378	129,976	126,546	123,146	119,741	116,450	113,244
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	-4.06e-06	1.56e-05	2.72e-05	2.48e-05	-1.48e-06	-8.76e-06	-3.51e-05
	-	(1.41e-05)	(1.66e-05)	(1.94e-05)	(2.16e-05)	(2.53e-05)	(2.95e-05)	(3.50e-05)
Obs.	-	144,927	140,743	136,570	132,452	128,404	124,515	120,755
No. Mothers	-	130,267	126,862	123,434	120,022	116,617	113,341	110,145

Panel B: Only ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000219	3.09e-05	6.35e-05	9.27e-05**	6.43e-05	3.19e-05	3.45e-06	-2.69e-05
	(0.00117)	(4.14e-05)	(4.34e-05)	(4.57e-05)	(4.76e-05)	(5.13e-05)	(5.55e-05)	(6.37e-05)
Obs.	76,768	76,768	76,768	76,768	76,768	76,768	76,768	76,768
No. Mothers		71,501	71,501	71,501	71,501	71,501	71,501	71,501
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-0.000125	-1.54e-06	3.92e-05	7.88e-05*	4.86e-05	1.96e-05	-9.71e-06	-4.39e-05
	(0.00116)	(3.29e-05)	(3.63e-05)	(4.08e-05)	(4.35e-05)	(4.89e-05)	(5.44e-05)	(6.41e-05)
Obs.	72,709	72,709	72,709	72,709	72,709	72,709	72,709	72,709
No. Mothers		67,783	67,783	67,783	67,783	67,783	67,783	67,783

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=3,4,...,9) times 360 is the estimated association of the likelihood of being breastfed for at least 3, 4, ... , 9 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated in which mothers' fixed-effects are controlled. Each entry under "months"times 360 is the fixed-effect estimated association of months breastfed with exposure to a full month of Ramadan during the 270-day period before birth. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.4 (continued): Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a male child being breastfed for at least 10, 11, . . . , or 16 months (mothers' fixed-effect regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	-2.30e-05	-2.02e-05	-4.45e-05	-7.88e-06	-3.96e-05	8.03e-06	-1.54e-05
	(4.26e-05)	(4.66e-05)	(4.99e-05)	(6.29e-05)	(6.71e-05)	(7.30e-05)	(7.73e-05)
Obs.	120,753	117,268	113,220	109,286	105,506	101,882	98,322
No. Mothers	110,220	107,245	103,830	100,492	97,250	94,147	91,103
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	-2.72e-05	-2.46e-05	-3.80e-05	3.84e-06	-3.55e-05	1.51e-05	-7.67e-06
	(3.95e-05)	(4.44e-05)	(4.78e-05)	(6.26e-05)	(6.73e-05)	(7.36e-05)	(7.83e-05)
Obs.	117,146	113,696	109,694	105,797	102,072	98,491	94,973
No. Mothers	107,124	104,157	100,750	97,419	94,205	91,117	88,085

Panel B: Only ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	13 months	14 months	15 months	16 months	
HER270b	-1.99e-05	7.34e-07	-2.32e-05	5.59e-05	1.13e-05	8.13e-05	8.02e-05
	(6.67e-05)	(7.04e-05)	(7.25e-05)	(8.51e-05)	(8.65e-05)	(9.00e-05)	(8.99e-05)
Obs.	76,768	76,768	76,768	76,768	76,768	76,768	76,768
No. Mothers	71,501	71,501	71,501	71,501	71,501	71,501	71,501
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	-3.91e-05	-1.51e-05	-3.83e-05	6.19e-05	1.06e-05	8.28e-05	7.34e-05
	(6.76e-05)	(7.19e-05)	(7.43e-05)	(8.86e-05)	(9.05e-05)	(9.45e-05)	(9.47e-05)
Obs.	72,709	72,709	72,709	72,709	72,709	72,709	72,709
No. Mothers	67,783	67,783	67,783	67,783	67,783	67,783	67,783

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=10,11,...,16) times 360 is the estimated association of the likelihood of being breastfed for at least 10, 11, ... , 16 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated in which mothers' fixed-effects are controlled. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.5: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a female child being breastfed for at least 3, 4, . . . , or 9 months (OLS regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:								
Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	6.41e-06	1.36e-05*	1.78e-05*	1.98e-05*	2.07e-05*	2.24e-05*	1.88e-05
	-	(5.65e-06)	(7.48e-06)	(9.78e-06)	(1.04e-05)	(1.20e-05)	(1.27e-05)	(1.29e-05)
No. breastfed < i months	-	5531	6377	7059	7613	8905	9557	10596
No. breastfed ≥ i months	-	136745	131820	127093	122509	117261	112846	108275
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	2.10e-06	8.78e-06	1.32e-05	1.58e-05*	1.69e-05	1.74e-05	1.10e-05
	-	(3.93e-06)	(7.26e-06)	(9.08e-06)	(9.05e-06)	(1.14e-05)	(1.22e-05)	(1.24e-05)
No. breastfed < i months	-	1,935	2,821	3,533	4,115	5,435	6,128	7,200
No. breastfed ≥ months	-	136,745	131,820	127,093	122,509	117,261	112,846	108,275

Panel B: Only ever-breastfed children are included:								
Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000825	7.46e-06	1.80e-05	2.63e-05	3.16e-05	2.83e-05	2.67e-05	1.82e-05
	(0.000564)	(1.42e-05)	(1.89e-05)	(2.20e-05)	(2.30e-05)	(2.29e-05)	(2.56e-05)	(2.64e-05)
No. breastfed < i months	74,767	5,715	6,643	7,405	8,054	9,484	10,276	11,464
No. breastfed ≥ i months		68,689	67,761	66,999	66,350	64,920	64,128	62,940
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000728	-5.22e-07	1.12e-05	2.06e-05	2.64e-05	2.32e-05	2.18e-05	1.30e-05
	(0.000494)	(8.88e-06)	(1.62e-05)	(1.94e-05)	(2.03e-05)	(2.21e-05)	(2.41e-05)	(2.44e-05)
No. breastfed < i months	70,649	1,990	2,918	3,680	4,329	5,759	6,551	7,739
No. breastfed ≥ i months		68,689	67,761	66,999	66,350	64,920	64,128	62,940

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=3,4,...,9) times 360 is the estimated association of the likelihood of being breastfed for at least 3, 4, ... , 9 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated by the OLS method in these cases. Each entry under "months"times 360 is the OLS estimated association of months breastfed with exposure to a full month of Ramadan during the 270-day period before birth. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.5 (continued): Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a female child being breastfed for at least 10, 11, . . . , or 16 months (OLS regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:							
Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	2.90e-05**	1.87e-05	7.32e-06	6.52e-06	6.35e-06	1.31e-05	1.66e-05
	(1.10e-05)	(1.28e-05)	(1.36e-05)	(1.67e-05)	(1.71e-05)	(2.02e-05)	(2.08e-05)
No. breastfed < i months	12,003	12,962	13,475	20,219	21,184	23,343	25,452
No. breastfed ≥ i months	103,278	98,933	94,601	84,097	79,443	73,754	68,241
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	2.12e-05*	1.25e-05	3.55e-06	3.87e-06	2.79e-06	7.19e-06	9.71e-06
	(1.08e-05)	(1.13e-05)	(1.19e-05)	(1.76e-05)	(1.79e-05)	(2.08e-05)	(2.02e-05)
No. breastfed > i months	8,646	9,634	10,191	16,978	17,974	20,174	22,324
No. breastfed ≥ i months	103,278	98,933	94,601	84,097	79,443	73,754	68,241
Panel B: Only ever-breastfed children are included:							
Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	3.14e-05	2.14e-05	1.14e-05	2.15e-05	2.61e-05	3.08e-05	3.38e-05
	(2.47e-05)	(2.73e-05)	(2.87e-05)	(3.42e-05)	(3.61e-05)	(3.65e-05)	(3.28e-05)
No. breastfed < i months	13,041	14,194	14,950	22,045	23,385	25,997	28,627
No. breastfed ≥ i months	61,363	60,210	59,454	52,359	51,019	48,407	45,777
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	2.73e-05	1.74e-05	6.48e-06	1.81e-05	2.37e-05	2.88e-05	3.20e-05
	(2.29e-05)	(2.42e-05)	(2.55e-05)	(3.28e-05)	(3.54e-05)	(3.61e-05)	(3.19e-05)
No. breastfed < i months	9,316	10,469	11,225	18,320	19,660	22,272	24,902
No. breastfed ≥ i months	61,363	60,210	59,454	52,359	51,019	48,407	45,777

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=10,11,...,16) times 360 is the estimated association of the likelihood of being breastfed for at least 10, 11, ... , 16 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated by the OLS method in these cases. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.6: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a female child being breastfed for at least 3, 4, . . . , or 9 months (mothers' fixed-effect regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	4.84e-06	1.68e-05	3.29e-05	4.47e-05*	6.43e-05**	5.60e-05*	6.55e-05*
	-	(2.01e-05)	(2.26e-05)	(2.44e-05)	(2.71e-05)	(3.05e-05)	(3.34e-05)	(3.71e-05)
Obs.	-	142,276	138,197	134,152	130,122	126,166	122,403	118,871
No. Mothers	-	127,246	123,961	120,644	117,361	114,075	110,936	107,979
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	-	1.79e-05	3.06e-05*	4.60e-05**	5.73e-05**	7.51e-05***	6.58e-05**	7.68e-05**
	-	(1.34e-05)	(1.69e-05)	(1.92e-05)	(2.25e-05)	(2.70e-05)	(3.02e-05)	(3.47e-05)
Obs.	-	138,680	134,641	130,626	126,624	122,696	118,974	115,475
No. Mothers	-	124,377	121,079	117,757	114,464	111,167	108,042	105,081

Panel B: Only ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000900	5.06e-05	5.52e-05	6.72e-05	7.84e-05	6.25e-05	7.24e-05	8.43e-05
	(0.00110)	(3.74e-05)	(4.20e-05)	(4.48e-05)	(4.78e-05)	(5.38e-05)	(5.65e-05)	(6.03e-05)
Obs.	74,404	74,404	74,404	74,404	74,404	74,404	74,404	74,404
No. Mothers		69,075	69,075	69,075	69,075	69,075	69,075	69,075
Exposure	Case 2: Never-breastfed children are excluded:							
Measure:↓	months	3 months	4 months	5 months	6 months	7 months	8 months	9 months
HER270b	0.000517	9.04e-06	1.62e-05	3.14e-05	3.66e-05	4.59e-05	5.80e-05	7.40e-05
	(0.00111)	(3.13e-05)	(3.72e-05)	(4.11e-05)	(4.47e-05)	(5.31e-05)	(5.63e-05)	(6.10e-05)
Obs.	70,679	70,679	70,679	70,679	70,679	70,679	70,679	70,679
No. Mothers		65,676	65,676	65,676	65,676	65,676	65,676	65,676

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=3,4,...,9) times 360 is the estimated association of the likelihood of being breastfed for at least 3, 4, ... , 9 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated in which mothers' fixed-effects are controlled. Each entry under "months"times 360 is the fixed-effect estimated association of months breastfed with exposure to a full month of Ramadan during the 270-day period before birth. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.

Table E.3.6 (continued): Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day period before birth on months of breastfeeding and on the likelihood of a female child being breastfed for at least 10, 11, . . . , or 16 months (mothers' fixed-effect regressions)

Panel A: Currently being breastfed and ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	5.62e-05	1.99e-05	1.56e-05	6.28e-05	7.85e-05	0.000121	0.000145*
	(4.17e-05)	(4.56e-05)	(4.88e-05)	(6.25e-05)	(6.71e-05)	(7.35e-05)	(7.97e-05)
Obs.	115,281	111,895	108,076	104,316	100,627	97,097	93,693
No. Mothers	104,973	102,165	98,963	95,815	92,672	89,663	86,762
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	6.58e-05*	2.72e-05	2.40e-05	7.32e-05	8.33e-05	0.000116	0.000136*
	(3.99e-05)	(4.43e-05)	(4.76e-05)	(6.27e-05)	(6.75e-05)	(7.43e-05)	(8.11e-05)
Obs.	111,924	108,567	104,792	101,075	97,417	93,928	90,565
No. Mothers	102,080	99,275	96,102	92,968	89,834	86,840	83,952

Panel B: Only ever-breastfed children are included:

Exposure	Case 1: Never-breastfed children are included:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	5.31e-05	-1.92e-05	-5.59e-05	-3.32e-05	-3.97e-05	4.75e-05	5.88e-05
	(6.64e-05)	(7.07e-05)	(7.24e-05)	(8.43e-05)	(8.61e-05)	(8.94e-05)	(9.16e-05)
Obs.	74,404	74,404	74,404	74,404	74,404	74,404	74,404
No. Mothers	69,075	69,075	69,075	69,075	69,075	69,075	69,075
Exposure	Case 2: Never-breastfed children are excluded:						
Measure:↓	10 months	11 months	12 months	13 months	14 months	15 months	16 months
HER270b	4.08e-05	-3.16e-05	-7.14e-05	-4.33e-05	-4.36e-05	4.39e-05	5.82e-05
	(6.80e-05)	(7.27e-05)	(7.45e-05)	(8.80e-05)	(8.99e-05)	(9.35e-05)	(9.60e-05)
Obs.	70,679	70,679	70,679	70,679	70,679	70,679	70,679
No. Mothers	65,676	65,676	65,676	65,676	65,676	65,676	65,676

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Each entry under "*i* months"(i=10,11,...,16) times 360 is the estimated association of the likelihood of being breastfed for at least 10, 11, ... , 16 months with exposure to a full month of Ramadan during the 270-day period before birth for a male child in the subgroup specified in the top rows. Linear probability models are estimated in which mothers' fixed-effects are controlled. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Obs. is the abbreviation for number of observations. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

E.4: Maternal Delivery and postpartum complications

Table E.4.1: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day and three 90-day (trimesters) periods before birth on the likelihood of maternal delivery and post-delivery complications

Exposure	Dependent variables (Y) for boys				Dependent variables (Y) for girls			
Measures:↓	PLABOR	EBLEED	INFECT	CONVOL	PLABOR	EBLEED	INFECT	CONVOL
HER270b	2.72e-05	2.28e-05	-5.77e-05	4.71e-05*	2.36e-05	-8.38e-05**	-7.07e-05*	-4.33e-05*
	(4.68e-05)	(2.29e-05)	(3.79e-05)	(2.34e-05)	(3.31e-05)	(3.01e-05)	(3.60e-05)	(2.40e-05)
HER190b	3.60e-05	3.87e-05	-7.40e-05*	4.32e-05	1.44e-05	-9.35e-05***	-9.61e-05**	-4.52e-05
	(5.91e-05)	(3.22e-05)	(4.13e-05)	(3.53e-05)	(3.71e-05)	(2.86e-05)	(4.26e-05)	(2.72e-05)
HER290b	6.41e-05	5.22e-05*	-8.07e-05	5.34e-05*	6.68e-05	-5.07e-05	-4.31e-05	-7.26e-05**
	(5.95e-05)	(2.94e-05)	(4.88e-05)	(2.56e-05)	(5.54e-05)	(4.88e-05)	(2.92e-05)	(3.13e-05)
HER390b	6.90e-06	-3.25e-06	-3.78e-05	5.02e-05***	2.06e-05	-8.14e-05*	-5.02e-05	-3.35e-05
	(4.02e-05)	(3.00e-05)	(4.69e-05)	(1.73e-05)	(3.84e-05)	(4.54e-05)	(4.16e-05)	(2.40e-05)
Obs. if Y=0	29,391	40,198	32,723	34,159	27,249	36,546	30,427	31,723
Obs. if Y=1	8,791	7,315	3,711	3,973	7,840	6,581	3,479	3,306

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each estimated coefficient times 360 shows the association of binary dependent variables specified in the second row with exposure to a full month of Ramadan during the corresponding time period before birth for a male or female child. The dependent variables are prolonged labor (PLABOR), excessive bleeding (EBLEED), high fever and discharge (INFECT), and convulsion (CONVOL). Linear probability models are estimated by OLS method. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mother's height, and households' wealth indicator. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.
Data Source: Demographic and health surveys, the DHS Program, USAID.

E.5: Maternal Pregnancy complications

Table E.5.1: Muslim-nonMuslim differential effects of an hour of exposure to Ramadan during the 270-day and three 90-day periods (trimesters) before birth on the likelihood of maternal pregnancy complications

Exposure	Boys			Girls		
Measures:↓	HBA	BLEED	NIGHTB	HBA	BLEED	NIGHTB
HER270b	-6.08e-05	-2.12e-05	-3.22e-05*	-5.26e-05	1.30e-05	-1.35e-05
	(4.15e-05)	(4.33e-05)	(1.65e-05)	(5.42e-05)	(1.42e-05)	(2.36e-05)
HER190b	-6.17e-05	-1.58e-05	-5.12e-05**	-4.98e-05	7.59e-06	-1.59e-05
	(3.63e-05)	(7.91e-05)	(2.38e-05)	(7.74e-05)	(2.18e-05)	(2.85e-05)
HER290b	-0.000197***	-7.61e-05*	-4.03e-05	-0.000167	-3.27e-05	-2.37e-05
	(3.72e-05)	(3.46e-05)	(2.48e-05)	(0.000122)	(4.92e-05)	(2.04e-05)
HER390b	-5.50e-05	-2.08e-05	-1.21e-05	-4.89e-05	1.83e-05	-8.76e-06
	(7.99e-05)	(3.63e-05)	(1.53e-05)	(7.47e-05)	(4.80e-05)	(3.13e-05)
Obs. if Y=0	24,805	31,546	62,526	22,112	27,931	58,570
Obs. if Y=1	9,104	3,269	5,873	7,907	2,924	5,391

Notes: Variable HER270b contains hours of exposure to Ramadan during the 270-day period before birth. Variables HER190b, HER290b, and HER390b contain hours of exposure to Ramadan during the first, second, and third 90-day periods (trimesters) before birth. Each estimated coefficient times 360 shows the association of binary dependent variables specified in the second row with exposure to a full month of Ramadan during the corresponding time period before birth for a male or female child. The dependent variables are severe headache, blurry vision, and abdomen pain (HBA), bleeding (BLEED), and night blindness (NIGHTB). Linear probability models are estimated by OLS method. Control variables in the regressions are children's year, month, and order of birth, an urban/rural indicator, a variable that indicates country and province of residence, parents' age at children's birth, parents' education, mothers' height, and households' wealth indicator. Standard errors, presented in parentheses, are clustered at country level. The statistical significance levels at the 1, 5, and 10 percent are indicated by ***, **, and *, respectively.

Data Source: Demographic and health surveys, the DHS Program, USAID.