RESILIENCE TO EARLY LIFE SHOCKS

Evidence from the Interaction of a Randomized Controlled Trial and a Natural Experiment[*]

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Abstract

Recent studies have documented the immediate and lasting effects of trauma in early life, but little is understood about how to protect children from these negative impacts. Protective effects are difficult to identify empirically, because both preventative and corrective investments are endogenous choices. We leverage a unique combination of events, in which a tornado struck an area of northwest Bangladesh involved in a double-blind cluster randomized controlled trial (RCT) of vitamin A supplementation–along with detailed birth records, morbidity and anthropometric measurements at 0-6 months–to test whether early life investment can mitigate the negative effects of experiencing a natural disaster. Exposure to the tornado *in utero* and at 0-3 months had large negative impacts on infants' anthropometric outcomes, and increased the frequency of severe fevers. However, infants treated with vitamin A at birth through the RCT were largely protected from these effects. Our results imply that simple health interventions can protect effectively against trauma in early life and that more research on the role of micronutrients in infant's resilience to shocks is likely to be valuable.

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1 Introduction

Recent studies from around the world have demonstrated that trauma *in utero* and in early life can have large impacts on the health and survival of infants and young children. The sources of trauma are many and variegated. Air and water pollution (Chay and Greenstone, 2003a,b; Currie and Neidell, 2005; Currie and Walker, 2011; Currie et al., 2009, 2011; Greenstone and Hanna, 2011); natural disasters (Cas et al., 2014; Frankenberg et al., 2011); income shocks (Baird et al., 2011; Bhalotra, 2010); nutrient scarcity (Almond et al., 2011); maternal stress (Persson and Rossin-Slater, 2014); poor sanitation (Watson, 2006); and limited access health care (Almond et al., 2006) all have adverse effects on child health and wellbeing.

This mounting evidence begs the question: how do we protect vulnerable children? In other words, is it possible to engender resilience to early life shocks? This question is not answered easily. While it is plausible that exposure to many types of early-life shocks, including those mentioned above, is effectively random, measures taken to prevent negative impacts–and measures to mitigate impacts once a shock has occurred–are likely not random at all. They are deliberate choices. The extent to which parents invest in restoring their child's wellbeing after a shock is likely correlated with unobserved characteristics that also determine the child's outcomes. Assessing outcomes after these endogenous choices thus cannot produce a rigorous conclusion regarding how much a particular investment actually contributes to resilience.

In this paper, we study a unique situation that by chance combined an exogenous negative shock with a randomized health intervention in early life, thus allowing us to answer this question (applied, of course, to our particular setting). On March 20, 2005, a tornado struck several areas of northwest Bangladesh that were involved in a double-blind cluster randomized controlled trial (RCT) of maternal and newborn vitamin A supplementation. The tornado killed 56 people and injured almost 4000, and generated significant property damage in about 7 percent of the villages under study (Sugimoto et al., 2011). Both treatment and control villages were affected. We leverage this rare combination of events–along with detailed birth records, morbidity and anthropometric measurements at 0, 3, and 6 months–to test whether vitamin A supplementation mitigates the negative effects of experiencing a natural disaster in early life.[1]

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[1] The protective role of vitamin A has a well charted physiological basis. Vitamin A promotes the functioning of neutrophils, macrophages, and natural killer cells – vital components of the body's immune system. It also helps restore innate immunity after infection by promoting the normal regeneration of mucosal barriers (Stephensen, 2001).

Our main focus is on the role of infant supplementation in promoting resilience. This is for two reasons. First, the primary goal of the prenatal supplementation RCT was to evaluate vitamin A's ability to stem maternal mortality, while the nested newborn supplementation trial focused directly on infant mortality. Second, the maternal trial showed small and statistically insignificant impacts of prenatal vitamin A or β-carotene supplementation on maternal, fetal, and infant mortality. The infant trial, on the other hand, found very large impacts on infant mortality–approximately a 15% reduction compared to the placebo group. For both reasons, it is more probable that infant supplementation exhibited a larger protective capacity than prenatal vitamin A. Consistent with this interpretation, we find little impact of the maternal trial on birth outcomes, anthropometry in early life, and the like, and little evidence that it is protective, while infant supplementation exhibits large protective effects.

Our empirical strategy exploits the contemporaneous combination of this RCT and a natural experiment. To estimate the effects of the tornado, we compare the health of cohorts of infants who were *in utero* or in early life (0-3 months) at the time of the tornado to earlier and later cohorts, across villages (also called sectors) falling within and outside the tornado's path. Then, to identify the potential protective effects of vitamin A supplementation, we add a third difference, across treatment and control sectors.

We show that exposure to the tornado *in utero* and at 0-3 months had substantial negative impacts on key birth outcomes and anthropometric measures in early infancy–namely mid-upper arm circumference (MUAC) and chest circumference (CC)–and increased the frequency of severe fevers in infancy. However, those treated with vitamin A at birth through the RCT were effectively protected from these deleterious effects. For example, a standardized anthropometric index at 3 months, constructed for mean effects analysis (Kling et al., 2007), dropped by .31 SD if the child was exposed to the tornado at 0-3 months in a placebo (control) sector. That difference all but vanishes for the same exposed cohort in treatment sectors. This pattern is consistent for anthropometrics at 6 months. Results on the incidence of fevers between 0 and 3 months reinforce the results on anthropometric outcomes: exposure to the tornado in the first three months of life increases the incidence of severe fevers, but this impact is wholly blunted in treatment sectors.

To our knowledge, ours is the first study to demonstrate in rigorous fashion that it is possible to protect against the deleterious effects of early life trauma. We show that health investments in early life can engender resilience to negative shocks. This result adds to our understanding of the health and economic impacts of changes in the early-life environment (Almond and Currie, 2011; Currie and Vogl, 2012; Heckman, 2006, 2007). Crucial to this understanding is the interplay between endowments and investments in the production of child quality (Almond and Mazumder, 2012; Bhalotra and Venkataramani, 2011; Cunha et al., 2013, 2010). We show that, at least in infancy, there is a high degree of substitutability between endowments and investments. In particular, vitamin A supplementation can make up for deficits in health endowments generated by tornado exposure. This amounts to a confirmation of the structural estimates of Cunha et al. (2010), using for the first time independent, exogenous sources of variation in both the endowment and investment. Since the RCT did not track infants beyond 6 months, we cannot determine whether this substitutability persists for longer-term outcomes. Though much more work is needed in this area, our findings suggest that it is indeed possible to protect young children from the lifelong disadvantage that can result from early life trauma.

Our result is also very related to recent work suggesting that intervention at birth (Almond et al., 2011, 2010, 2006; Bharadwaj et al., 2013) and investment in children (Gould et al., 2011; Kling et al., 2007) can in some cases correct for health-related or economic disadvantage. These studies show that early investments can improve the survival, health, and general welfare of children with low baseline health or economic status.

Our findings add to this literature in two ways. First, we measure a preventative–as opposed to a corrective–effect of investments at birth. Taken together, then, the evidence to date demonstrates that investments at birth work toward both improving outcomes after fetal disadvantage as well as protecting against trauma in early infancy. Second, this previous work has focused on identifying the returns to early intervention for children with poor endowments. But what would the returns have been if we had provided the same level of investment to less at-risk children? A large part of this gap in the literature is because the policies evaluated explicitly target at-risk children. We leverage the unique combination of an RCT and a natural experiment to quantify the impacts of intervention across both "disadvantaged" (exposed to the tornado) and "healthy" (not exposed) children. We show that that the returns to vitamin A supplementation are much larger for disadvantaged infants compared to those for healthier babies.

Finally, we provide evidence in support of policies encouraging vitamin A supplementation at birth in low-income contexts. Our results suggest that much of the impact of supplementation can be attributed to the large benefits accruing to the most distressed infants (in this case, to tornado-affected infants, and more suggestively, to low birth weight babies). Moreover, the effect of infant vitamin A supplementation on anthropometric measures at 3 and 6 months for "healthy" children (not exposed to the tornado) is very small. This idea–that there exists significant heterogeneity in the impact of basic supplementation–has not been properly emphasized in the public health literature on vitamin trials in low-income contexts.[2] To enhance their impact, supplementation policies should thus target distressed infants, particularly those living through traumatic experiences – natural disasters, disease outbreaks, war, and the like – in the first few months of life.

The remainder of the paper is organized as follows. Section 2 provides details regarding the vitamin A supplementation RCT and the tornado event. Section 3 describes our data, and section 4 describes the empirical strategy. Section 5 describes the results, and section 6 concludes.

2 Context

2.1 The RCT

The two randomized field experiments we study were nested double-blind placebo-controlled cluster randomized trials of maternal and newborn vitamin A (and in the maternal trial, β-carotene) supplementation in Bangladesh, conducted from 2001 to 2007. These trials and the tornado survey referred to below were all approved by the Institutional Review Board of the Bloomberg School of Public Health, Johns Hopkins University, and the Ethics Committee of the Bangladesh Medical Research Council. Each of the trials was pre-registered at clinicaltrials.gov; Identifiers: NCT00198822 (maternal trial) and NCT00128557 (infant trial).

The RCTs are part of the JiVitA Bangladesh international nutrition research project on maternal and child health. Both trials were conducted in a contiguous 435 square kilometer area in northwest Bangladesh, in Rangpur Division, with an estimated population of about 600,000. The study site is typical of rural Bangladesh, lying at approximately the 35th percentile of the distribution of economic and quality of life indicators among rural areas in Bangladesh (see Labrique et al. (2011) for more details on representativeness of the study area).

The study area was subdivided into 596 sectors, each of which was populated with 107 to 377 households at baseline. These sectors were randomized using a 3x2 cluster randomized factorial design with three different groups for pregnant women and 2 groups for their newborn children. The 3-group ran-

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[2] See, e.g., Binka et al. (1995); Grotto et al. (2003); Imdad et al. (2011); Zeba et al. (2008).

domization (maternal trial) used a geographic block randomization, which is described in detail in West et al. (2011). The 2-group randomization (infant trial) was done by geographic block randomization, where each block was defined within one of the three earlier groups, as described in Klemm et al. (2008).

All married women in the study area in 2001 (totaling 102,769) and newlywed women (during the study, totaling 27,711), ages 13-45, were surveilled for pregnancy. In total, 60,294 pregnancies were identified and, if consent was given (>99% of cases), the pregnant woman was enrolled in the maternal supplementation study. The infant trial was nested within the maternal trial and was conducted during part of the maternal trial, or between January 2004 and December 2006. A total of 15,937 infants received supplementation (or placebo) directly at birth or shortly thereafter (79% within 24 hours; 90% within 1 week) and were followed until 6 months after birth.

The two treatment groups in the maternal trial received the recommended weekly allowance of vitamin A, either in the form of vitamin A or β-carotene (which the body converts into vitamin A), as weekly supplements from first trimester through 12 weeks post-partum, while the control group received a placebo supplement. Live-born infants in each sector were randomized to receive either 50,000 International Units (IU) of vitamin A once at birth or to receive placebo once at the same time. Further information on field procedures and other details can be found in Labrique et al. (2011), West et al. (2011) and Klemm et al. (2008).

As mentioned in the introduction, our analysis focuses primarily on the infant RCT. The main purpose of the maternal trial was the assess the impact of prenatal supplementation on maternal outcomes, which should be, of course, indirectly linked to infant resilience, but not in the direct way that the infant RCT was. Moreover, vitamin A treatment at birth generated large impacts on infant mortality, while maternal supplementation did not; we verify that these contrasting sets of results apply for anthropometric outcomes as well.

2.2 The Tornado

On the night of March 20th, 2005, a tornado swept through Gaibandha District, affecting about 7% of the study area (Sugimoto et al., 2011) (see Figure 1). Between August and October 2005 each household in affected areas was visited by a survey enumerator, who asked questions on mortality and morbidity of household members as well as damage to homes as a result of the tornado. Based on this survey, the tornado resulted in 56 deaths, injured 3,710 people and destroyed 3,540 houses (Sugimoto et al.,

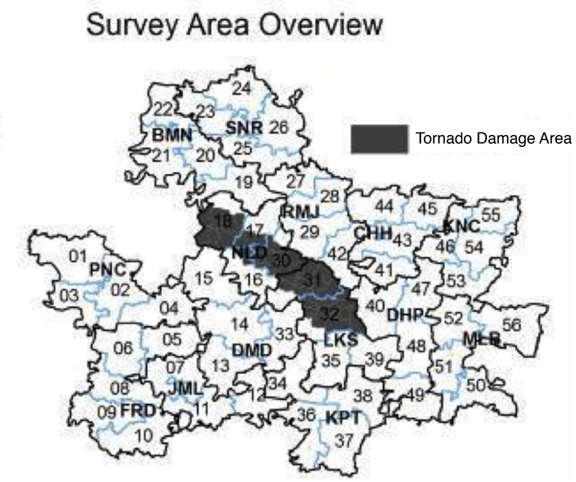

Figure 1: Area damaged by the tornado. The figure was produced by the JiVitA GIS Unit.

2011). Out of 596 study sectors, 41 sector had some houses destroyed and in 24 sectors more than 20% of houses were destroyed. Many actors responded to the disaster – including local NGO's, local and national government and even the medical team of the two Vitamin A trials – providing medical care and supplies of rice, cash and building supplies. Our estimates below of the impact of the tornado should be considered as net of the effect that this relief effort had. Our evidence suggests that the tornado had no effect on the timing of supplementation or anthropometric and survey measurements. For instance, among infants in their second or third trimesters in-utero during the tornado those in the tornado area were supplemented within 24 hours at the rate of 80% while those outside of this area were dosed at the rate of 79.2%. Birth anthropometry for this same population was obtain within 7 days in the tornado area at the rate of 88.2% and outside this area at the rate of 89.5%.

3 Data

3.1 Sample

We include in the sample all infants in the trial born before July 20, 2006 (following Klemm et al. (2008)) for which informed consent was obtained but exclude non-singleton births (298 infants) and those we can not assign to a cohort due to missing data (63 infants). This leaves us with a final core analysis sample of 18,787 infants.

3.2 Summary Statistics

Table 1 reports means and standard deviations of important outcomes and control variables. We code as missing birth measures taken after 7 days and 3 and 6 month measures taken more than 8 weeks after the target date (in our regressions we also control for the date of measurement). We report means for the whole sample, as well as within and outside of tornado-affected sectors, and across treatment and control sectors within the tornado area. We also report differences in means across these sub-samples. Differences noted with asterisks denote statistically significant differences.

Babies in this area of Bangladesh are small relative to reference populations. The mean weight is 2.5 kg, exactly at the threshold for classification as low birth weight. Average length at birth in cm is approximately 46.7, a full 3 cm less than the reference US population. Head circumference is 32.7 cm at birth, which is 3 cm less than the same measurement for the reference US population. This difference (with respect to the reference population) shrinks slightly by 6 months: head circumference at 6 months is 40.89 cm as compared to 43.5 cm for reference infants.[3]

3.2.1 Comparisons across affected and unaffected areas and across study arms within tornado sectors

Means of health outcomes at birth and at 3 and 6 months are balanced across the tornado and non-tornado areas for pre-tornado cohorts. There is some evidence that infants in tornado-affected sectors were slightly healthier, particularly by 6 months: 9 out of the 11 anthropometric measurements recorded are larger in the tornado area; 3 of these differences–mid-upper arm circumference, chest circumference, and an anthropometric index, all at 6 months–are statistically significant, though the differences are small in magnitude.[4]

Next, we compare means across treatment sectors (infants who received vitamin A supplementation at birth) and control (placebo) sectors within the tornado-affected area. Reassuringly, child outcomes (weight and anthropometry at 0, 3, and 6 months) are balanced across the treatment arms within the

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[3] Data for reference populations are from the Centers for Disease Control and Prevention Growth Charts for the United States (Kuczmarski et al., 2000).

[4] The anthropometric index (AI) is constructed as the normalized sum of the three (normalized) independent measures of anthropometry we have in the data: mid-upper arm circumference (MUAC), head circumference (HC), and chest circumference (CC). The normalization centers the mean of the index over the whole sample at 0 and standardizes the variance to 1. The AI is meant to be a summary measure of anthropometry at 3 and 6 months. Also note that all difference statistics reported in this table are not clustered.

tornado area. Two maternal characteristics, parity and education, are different across vitamin A and placebo groups.

3.2.2 Dosing

Infants were dosed within hours of birth with either treatment (vitamin A) or placebo. The trial was double blind, so the implementation teams did not know whether they were dosing infants with treatment or placebo. In Table 2, we report dummies reflecting the distribution of time to dosing (in hours after birth) across key groups.

48 percent of infants were dosed within 6 hours of birth. 62 percent were dosed within 12 hours, and 74 percent by 24 hours. The dose timing distribution has a long right tail: 16 percent of infants were dosed more than 7 days after birth. Overall, the distribution of dosing timing was fairly similar across tornado and non-tornado sectors, and within the tornado area across vitamin A and placebo groups. We do see small significant differences in dosing less than 6 and 12 hours (note that this is prior to the tornado). Tornado areas were dosed slightly *earlier* than non-tornado areas.

In Table A5, we verify that for *exposed* infant cohorts, dosing was actually more equal across tornado and non-tornado areas, and, within the tornado area, across vitamin A and placebo sectors.

3.2.3 Attrition

Finally, we address the possibility that the tornado (or infant vitamin A treatment) resulted in differential attrition from the sample. If this were the case, selective attrition might bias the estimates of the impacts of early life trauma and resilience due to vitamin A exposure. Attrition here is treated as "all-cause," meaning that our main variable of interest is whether child outcomes were not observed, for whatever reason, during the 0, 3, and 6 month enumerator visits. The two specific causes of attrition are death during infancy and migration from the survey areas; the rest of attrition comes from unspecified reasons.

We assess the extent to which attrition is differential across tornado-affected and unaffected cohorts, and then assess whether the triple interaction with vitamin A treatment predicts differential attrition, as well. In our main analysis, we calculate *in utero* exposure based on the period between best-guess date of conception and date of birth, but of course in this analysis we do not have date of birth for babies who were not found for birth measurement. We thus calculate periods based on the last-known menstrual period (LMP), which is used in the calculation of best-guess date of conception as well. We define the *in utero* period as 0-270 days after LMP; then 0-3 month exposure as 271-360 days after LMP; and 4-6 month exposure as 361-450 days after LMP. In this way we can define periods even for babies who are no longer present in the sample, making attrition analysis possible.

The results are reported in Table 3. The odd columns in the table (1, 3, and 5) report results using a binary variable equal to 1 when the measure at a particular period (birth, 3 and 6 months) is missing. The even columns (2, 4, and 6) report a similar dummy but include babies for whom the the measure was very late (after 7 days for birth anthropometry, and 8 weeks after the target date for 3 and 6 month measurements). We assign these variables to missing in our analyses as they represent mismeasurement of outcomes that is not necessarily linear (i.e., would not necessarily be appropriately absorbed by including controls for age at measurement, which we do in all regressions). For a breakdown of conditional means in these variables across the groups of interest, please refer to Table A1 in the appendix.

Overall, results at birth and 3 months show very little evidence of differential attrition for tornado-exposed infants, and the point estimates on the triple interaction with infant supplementation treatment are also insignificantly different from 0. At 6 months, we see significant differential attrition for tornado-exposed infants, but no such differences in the triple interaction. That is, by 6 months, there appears to be more attrition for tornado-exposed infants. This may be because mortality effects kick in only after 3 months, or because the tornado's economic effects do not manifest immediately. Regardless, sample selection will be an issue at 6 months. Encouragingly, the attrition issue is not present at 3 months, and we largely find the same effects on anthropometry, both for the effects of the tornado and the resilience generated by vitamin A, in both periods.

4 Empirical Strategy

4.1 Sources of variation

We leverage three sources of variation to identify the protective effect of vitamin A: 1) spatial variation in tornado exposure; 2) temporal overlap between the tornado event and key early life periods; and 3) the randomized allocation of vitamin A to newborns.

With regard to spatial variation, we compare infants born in sectors that were in the tornado's path with those born in sectors outside this path. Our baseline definition of spatial exposure classifies a particular sector as exposed if there was any tornado damage in the sector. Under this definition, 41 sectors, or 7 percent of all sectors involved in the RCT, were exposed. Since several sectors experienced a low degree of damage (less than 20 percent of homes were destroyed in 17 sectors), we may be misclassifying these sectors as "exposed" according to the baseline definition. We can thus define an alternative that includes only sectors affected to a greater degree – for example, sectors in which greater than 20 percent of homes were destroyed. Results are qualitatively unchanged when we use the alternative definition of spatial exposure. The caveat to using this alternative is that as we increase the cutoff, the number of exposed sectors shrinks, leading to imbalance in the sample across the exposed and unexposed groups, thus power goes down. A summary of tornado-affected sectors is provided in Table 4.

Second, we construct dummies for two main time periods of early exposure: the prenatal period (i.e., the infant was *in utero* during the tornado event) and early life (i.e., the infant was either 0-10 weeks or 0-22 during the tornado event, depending on the timing of the measurement of the outcome variable). Throughout the paper we define the *in utero* period as the time between our best guess of the date of conception (based on the last menstrual period) and birth. This definition has the advantage of being the normal definition of the *in utero* period but the disadvantage that it induces a mechanical correlation between exposure to shocks *in utero* and gestational length (Currie and Rossin-Slater, 2013). To account for this, control for best-guess length of gestation in our main specification.

For the postpartum period, we chose 10 rather than 12 (and 22 rather than 24) weeks because our measurements of anthropometric outcomes and the survey of mothers were done at 12 and 24 weeks postpartum. We thus leave at least 2 weeks' gap for the effects of the tornado to manifest themselves in infant outcomes.[5]

Third, we use randomized variation in the allocation of vitamin A to newborns by sector. Accordingly, we construct a dummy for whether the infant was born in a treatment sector, meaning he was dosed with vitamin A at birth. As explained earlier, supplementation at birth in the RCT was cross-randomized with prenatal supplementation. We focus on supplementation at birth in the body of the paper, and describe the prenatal supplementation results in the appendix.

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[5] For regressions using the history of fever episodes at 12 and 24 weeks as the dependent variables, we use the full 12 and 24 weeks of exposure, respectively, since fever should respond more immediately than anthropometry.

4.2 Estimation

Perhaps the most intuitive candidate strategy for identification of a protective effect for vitamin A is to compare infants born in some window of time around the tornado event, inside and outside the tornado area, and across treatment (vitamin A supplementation) versus control (placebo) sectors–a difference in differences strategy. This would, however, require two fairly strong assumptions for identification. First, we would have to assume that the tornado hit a random subset of sectors. This is clearly violated, as the tornado affected a spatially contiguous area. Second, we would need that the randomization was balanced both inside and outside the tornado-affected area. Due to the small number of sectors inside the tornado area, this assumption may not hold.

Our strategy, which leverages the timing of births using a triple difference specification, allows for much weaker assumptions. In particular, in the difference in differences strategy above, we would rely on a single (spatial) difference across tornado and non-tornado areas to identify the effects of the tornado. In contrast, here we can rely on both spatial and temporal variation (around the tornado window) to identify the tornado effect. That is, we can compare babies born at different times (within and outside of a window around the tornado event), across sectors affected by and unaffected by the tornado. Then, we can essentially compare the size of this effect across vitamin A treatment sectors and placebo sectors. This strategy also lowers concern about imbalance between the vitamin A and placebo sectors as we estimate how birth outcomes change over time rather than comparing main effects across sectors.

Finally, we must also assume that the tornado hit vitamin A and placebo sectors equally hard. This can be checked in the data. In fact, the average number of houses destroyed in the tornado hit vitamin A sectors was 33.7% compared to 47.6% in the tornado hit control sections. This is in part because the 6 sectors hit hardest (by this measure) were all control sectors. Excluding those sectors the average damage in tornado hit vitamin A sectors is 33.5% compared to 28.7% in the tornado hit control sectors. However, as discussed below and displayed in Table 15, our findings are unchanged (and in fact statistically stronger) if we exclude those sectors.

We thus estimate a triple difference across the three dimensions described above to identify the protective effect of vitamin A. We assess the impact of the tornado by comparing outcomes for infants across sectors affected by the tornado v. unaffected sectors and for those whose prenatal and early life periods coincided with the tornado timing v. those for whom these periods did not. We then take a third difference across treatment v. control sectors, to estimate the protective effect of vitamin A supplementation at birth.

In section 5, we begin by presenting the raw conditional means of key outcome variables (anthropometry, fever incidence, and mortality) within these groups. The differences across groups suggest a large negative impact of tornado exposure and an equally large protective effect of vitamin A supplementation.

We then estimate the full triple difference specification via ordinary least squares (OLS):

$$\begin{aligned} O_{ij} = \quad & \alpha + VitA_j \left(\beta_1 U_i + \beta_2 E_i + \beta_3 T_j U_i + \beta_4 T_j E_i \right) \\ & + \gamma_1 U_i + \gamma_2 E_i + \gamma_3 T_j U_i + \gamma_4 T_j E_i + X'_{ij}\delta + \mu_j + \varepsilon_{ij}. \end{aligned} \tag{1}$$

Here, i denotes infant and j denotes sector. O_{ij} is a health outcome measure. T_j is a dummy for tornado-exposed sector. U_i is a dummy that is 1 if the infant was *in utero* during the tornado event, and E_i is a dummy that is 1 if the infant was 0-10 weeks during the tornado. $VitA_j$ is a dummy for treatment sector in the RCT. μ_j is a sector fixed effect, which absorbs the main effects of vitamin A treatment and tornado sector classification (as well as the interaction of those two). X_{ij} is a vector of determinants of child health used as controls. Throughout the analysis, we cluster standard errors at the sector level, but in Table 13 we replicate the main results using two-way clustering on sector and week of birth.

5 Results

5.1 Birth outcomes

We begin with impacts on birth outcomes. The main purposes of this analysis are 1) to estimate the impacts of *in utero* exposure to the tornado on birth outcomes, and 2) to assess the protective effect of maternal (prenatal) supplementation with vitamin A or β-carotene. The main outcomes we assess as birth are birth weight, gestational age, small for gestational age (below 25th percentile birth weight adjusted for gestational age), height, MUAC, HC, CC, and a mean effects index comprised of all of the measurements at birth just mentioned.

Table 5 reports results of regressions of these outcomes on tornado exposure and its interaction with prenatal vitamin A supplementation. For nearly all variables, we estimate a substantial negative impact of *in utero* exposure. For example, the likelihood of low birth weight (birth weight < 2.5 kg) is higher by 15 percentage points; height decreases by .54 cm; and other anthropometric measurements (MUAC, HC, and CC) decline by .25 to .47 cm. In short, we find strong evidence of negative impacts of *in utero* tornado exposure on outcomes at birth.

The coefficients on the interaction of exposure with maternal supplementation with vitamin A are in general imprecisely estimated, but show a weak pattern towards protection. For example, the likelihood of low birth weight increases by 15 points with *in utero* tornado exposure, but one-third of that increase disappears for mothers receiving vitamin A supplementation during pregnancy. Overall, however, the results are not precise enough to claim conclusively that prenatal vitamin A or β-carotene supplementation has a role in protecting against *in utero* assault.

5.2 Anthropometry at 3 and 6 months

5.2.1 Preliminary Evidence

Next we present preliminary evidence from means across groups of the anthropometric index (AI) at 3 months. AI group means are reported in Table 6. There are three panels of two-by-two tables; each panel corresponds to a time period of birth relative to the time of the tornado event. The first panel reports means for infants born outside the tornado window, the second reports means for those with *in utero* exposure, and the third reports means for those with early life exposure. Each panel reports means across tornado v. non-tornado sectors and across vitamin A treatment v. placebo sectors (where treatment is supplementation with a single vitamin A dose at birth). This generates 4 means per panel. We also calculate differences across these groups, and a difference in differences estimate within each panel. Finally, we take the triple difference across panels. We report two such triple differences – one comparing *in utero* exposure (second panel) to no exposure (first panel), and one comparing early life exposure (third panel) to no exposure.

We begin with the first panel of Table 6. We see that outside the tornado window, there are fairly large differences across sectors falling within and outside of the tornado's path. In particular, babies born in tornado sectors have significantly better anthropometry (by .1 SD in treatment sectors and .14 SD in control sectors), in both vitamin A treatment and placebo sectors. This fact underscores the non-random selection of tornado sectors, and therefore the need for a third difference over time.

Reassuringly, there are no significant differences across treatment and placebo sectors, though, as we might expect given the smaller sample, the estimates are somewhat imprecise in tornado areas. The difference in differences estimate is also not significantly different from 0.

The second panel of Table 6 reports AI means at 3 months for infants exposed to the tornado *in utero*. In placebo sectors, mean AI in tornado areas was the same as in non-tornado areas (as compared to .14 SD higher in tornado areas for infants outside the tornado window), suggesting that the tornado had a large adverse effect on infants who were exposed *in utero*. In vitamin A treatment sectors, this difference was .1 SD, and thus the difference in differences estimate is essentially 0. None of these estimates is significantly different from 0. Overall, this panel provides limited evidence in support of the hypotheses that the tornado had an adverse impact on babies exposed *in utero*, and that vitamin A had a protective effect.

The third panel of Table 6, with 3 month AI means for infant exposed in early life to the tornado, shows large differences across groups. Non-tornado area means are essentially 0, as we would expect. In tornado areas, however, the mean AI in placebo sectors is -.11 SD, compared to .15 SD for infants outside the tornado window. This difference suggests a large negative impact of the tornado for infants exposed in the first 10 weeks of life. Yet in vitamin A treatment sectors, the tornado sector mean for exposed infants is the same as the mean AI in tornado areas (across vitamin A and placebo sectors) outside of the tornado time window.

Below these three panels, we report triple difference estimates for *in utero* and early life exposure. These estimates capture the corrective and protective effects of vitamin A, respectively. The triple difference estimate for the corrective effect of vitamin A after *in utero* exposure is .14 (and insignificant), and the estimate for the preventative effect is .31 and significantly different from 0.

We report an analogous set of means for AI at 6 months in Table 7. The pattern of differences is exactly the same as those reported in the previous table. The first panel demonstrates that, outside the tornado time window, infants in tornado sectors are significantly larger at 6 months than those born in non-tornado sectors. From the means in the second panel for infants exposed *in utero*, we see the same pattern, suggesting that the tornado did not have a large impact by 6 months for those infants exposed during gestation.

The third panel, however, with AI means for infants exposed in the first 22 weeks of life, suggests that the tornado did indeed impact these infants–the difference in the placebo group across tornado and non-tornado sectors is -.04, compared to .17 for infants outside the tornado time window, indicating a large impact of tornado exposure on these infants. Yet in the vitamin A treatment group, the difference across tornado and non-tornado sectors is .20, *larger* than the difference outside of the tornado time window. That is, those infants born in the vitamin A sectors appear protected from the negative impacts of the tornado in early life. The triple difference estimates are consistent with the difference in differences estimates from the separate panels and are significantly different from 0.

5.2.2 Regression Results

Next, we estimate impacts of the tornado for infants exposed *in utero* and in early life, as well as the corrective and protective effects of vitamin A supplementation, using linear regression models of the form shown in equation 1. We regress AI and, separately, its individual components–MUAC, CC, and HC at 3 and 6 months[6]–on the triple interaction of a vitamin A treatment sector dummy, a tornado area dummy, and a dummy for either *in utero* or early life (0-10 weeks) exposure (we include both triple interactions in the specification). All lower-level interactions and main effects are also included, as well as sector fixed effects, which absorb some of these main effects. In addition, we control in all models for the best guess length of gestation in weeks; in some models we also control for maternal MUAC, maternal height, and a living standards index, which is generated via principal components analysis using household assets data.

The results for AI and its components at 3 months are reported in Table 8. The triple interactions for *in utero* and early life exposure are reported at the top of the table. These tell us the magnitudes of the corrective and protective effects of vitamin A, respectively. Next, we report the double interactions with tornado area and being born in the tornado time window. These coefficients tell us the size of the negative effects of the tornado. We then report other double interactions, main effects, and controls.

The results in Table 8 generally confirm what we learned from the preliminary evidence from AI group means. We discuss AI results first, reported in columns 1 and 2 of the table. The interaction of birth in tornado area with early life exposure has a large and negative coefficient (-.31, $p<.05$); the coefficient on the interaction with in utero exposure is also negative, but smaller (-.17) and insignificant. In other words, we find that by 3 months, infants exposed in early life to the tornado were more than

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[6] Note that mid-upper arm circumference (MUAC), chest-circumference (CC) and head circumference (HC) are all measured in centimeters.

.3 SD smaller than non-exposed infants. The negative impacts of *in utero* exposure appear to diminish by 3 months, though the coefficient estimate is still negative.

The triple interaction coefficients suggest that vitamin A has a significant protective effect, dampening the impact of tornado exposure substantially. The coefficient on the triple interaction with early life exposure is .41 without controls (column 1) and .32 with controls (column 2), indicating that infants in vitamin A sectors were not significantly affected by the tornado, while those in placebo sectors experienced large negative impacts. The patterns for MUAC, CC and HC are similar; triple difference estimates of the protective effect of vitamin A are significantly different from 0 in both specifications (with and without controls) for MUAC and CC, but not HC. Length of gestation, maternal MUAC and height, as well as living standards, are all positively associated with anthropometry.

In Table 9, we show the negative impacts of the tornado and the protective effect of vitamin A both continue to be salient for anthropometry at 6 months. Indeed, the estimates of the tornado impact on AI, MUAC, CC and HC are all larger at 6 months compared to 3 months, as are the protective effects (read off the triple interactions). Again, we only find significant effects for early life exposure; in particular, only for exposure in the first 3 months, but not at 4-6 months. The impacts of *in utero* tornado exposure and mitigative impacts are both insignificant.

5.3 Fever Episodes

Next we present evidence on fever episodes, one mechanism underlying the impacts on anthropometric outcomes. Since vitamin A's primary role in infancy is to strengthen the immune system, we would expect that infants dosed with vitamin A at birth are less prone to fevers occurring because of poor nutrition, sanitation, and the like following tornado exposure. We test this hypothesis using data on infant fever episodes reported by mothers at 3 and 6 months.

Table 10 shows group means for the number of high (as classified by the respondent) fever episodes experienced in the first 3 months of life. The first panel shows that there were no differences in fever episodes across tornado and non-tornado areas or across vitamin A and placebo areas for infants outside the tornado time window. The average infant had just under 1 "high" fever episode in the first 3 months of life.

In the second panel, we report the same group means for infants born in the *in utero* exposure time window relative to the tornado. Here, we see significant differences in number of fever episodes across the tornado and non-tornado areas, indicating that *in utero* exposure was indeed detrimental for infants. In both vitamin A and placebo sectors, infants born in tornado areas had approximately .22 and .34 more fever episodes, respectively. The double difference estimate (.12) is small and insignificant, indicating that vitamin A had no corrective effect for this cohort of exposed infants. This evidence is consistent with the small observed impact on anthropometric outcomes.

In the third panel of Table 10, we report group means for cohorts coinciding with early life exposure to the tornado. We find that mean fever episodes in non-tornado areas was .86, consistent with the means for other cohorts reported in the previous panels. But the mean number of episodes in tornado areas that were placebo sectors in the RCT was 1.34, nearly .5 episodes (more than 50%) greater than non-tornado areas, while in tornado-exposed vitamin A sectors, the mean was unchanged, at .88. This difference is echoed in the triple difference estimates of the protective effect of vitamin A, offering powerful descriptive evidence that fevers indeed increased for infants exposed in early life, but this impact was mitigated by vitamin A supplementation.

The regression results for fever and episodes for 0-3 and 4-6 months, reported in Table 11, confirm these preliminary findings. The double interactions between tornado area and tornado time windows show that exposure to the natural disaster increased the incidence of fever for most types of exposure–*in utero* (in some specifications), at 0-3 months, and at 4-6 months. However, vitamin A had a protective effect for early life exposure (0-3 months), though this coefficient becomes insignificant when the triple interaction for 4-6 month exposure is added to the specification.

5.4 Robustness Checks

5.4.1 Restricting Control Group to Pre-Tornado Cohorts

In our main analysis, infants conceived after the tornado are considered part of the (temporal) control group. It is possible that these infants were affected by the aftermath of the tornado; for example, sanitation and health infrastructure likely took time to rebuild in affected areas, so infants born in some window well after the tornado could still have been exposed to its negative impacts.

To account for this possibility, we include additional interaction terms that effectively remove the cohort conceived after the tornado from the control group. Thus all cohorts are now compared only to the cohort born more than 3 months before the tornado. The results are reported in Table 12. We find that the results on AI, MUAC, and fever all retain their magnitudes and statistical significance. As we would predict, the inclusion of the cohort conceived after the tornado makes the estimates of tornado impact in early life and the protective effect of vitamin A stronger.

5.4.2 Two-way Clustering

In Table 13, we replicate the main results on AI, MUAC, and fever at 3 and 6 months using two-way clustering of standard errors on cluster (the unit of randomization) and week of birth (the unit of variation in exposure). The precision of estimates of the negative impacts of tornado exposure and the protective effect of infant vitamin A supplementation is largely unchanged.

5.4.3 Changing the Definition of Tornado Exposure

Our baseline variable for tornado exposure is an indicator that equals 1 for each infant if the sector in which the infant was born had a positive percentage of homes destroyed. Exposure might be better defined using higher cutoffs, because low levels of tornado damage may not generate large enough impacts on infant anthropometry to detect statistically. On the other hand, since defining the exposure cutoff at 0 yields about 10 percent of sectors defined as exposed, increasing the cutoff will yield a very small fraction of the sample classified as exposed. This creates small cells of infants who were born in exposed sectors around the time of the tornado, and thus estimates become more imprecise. We favor the "any exposure" definition to mitigate this latter concern, but we check whether exposure at higher cutoffs has similar effects.

To do implement this, we take our basic specification and divide tornado exposure into two dummies – one for 0-20 percent of homes destroyed, and one for 20-100 percent. We look at the double and triple interaction coefficients for each of these indicators. The results are presented in Table 14. We find in general that the size of the coefficients for both the impact of the tornado and the protective effect of vitamin A are not statistically different for both definitions of exposure, suggesting that our baseline definition seems to capture the appropriate variation in exposure.

Another possible concern for our estimates is that 6 of the most damaged sectors were all control sectors. As a result, among the tornado hit sectors, 47.6% of houses in control sectors were destroyed compared to 33.7% of houses in vitamin A sectors. If we exclude those 6 sectors most damaged then the balance shifts such that 28.7% of houses in control sectors are destroyed compared to 33.5% in the vitamin A sectors. We re-estimated our key regressions excluding these 6 sectors and report the findings in Table 15. Our findings are similar and in fact statistically stronger than before. It therefore appears unlikely that our findings are driven by control sectors being especially hard hit, at least not by our measure of residential house destruction.

6 Conclusion

Infants are vulnerable to a variety of assaults *in utero* and in early life. Quantifying the negative effects of environmental factors, income and nutritional scarcity, and natural disasters on infant health and survival is the focus of a rapidly expanding set of studies in economics. We know from this work that impacts, particularly in low-income contexts, can be large and long-lasting. But we have little rigorous empirical evidence that intervening in early life can change outcomes for children exposed to trauma.

In this study, we leverage the unique combination of a natural disaster during an RCT to estimate the negative impacts of tornado exposure on birth outcomes, and the protective effect of vitamin A supplementation at birth. We find significant impacts of the tornado on anthropometric outcomes at 3 and 6 months. But babies who received a one-time dose of vitamin A at birth did not experience the same drops in anthropometric measures. Results on the incidence of fever episodes in infancy reinforce these findings, lending some insight into the mechanism through which the protective capacity of vitamin A operates.

The results this study demonstrate, to our knowledge for the first time, that simple interventions at birth can protect effectively against trauma in early life. This is important because improving the health and survival of infants, particularly in low-income countries, is a primary goal for global health policy. Moreover, a growing literature in economics shows that in addition to these immediate impacts, early life assaults have far-reaching long run consequences. Disease (Almond, 2006; Bleakley, 2007, 2010; Cutler et al., 2010), natural disasters (Currie and Rossin-Slater, 2013), income shocks (Maccini and Yang, 2009), and war (Akresh et al., 2012) all leave lasting scars on health, human capital, and welfare that persist well into adulthood. The role of public policy in mitigating these impacts or protecting against them is widely recognized but poorly understood. In large part the dearth of rigorous evidence on policy levers is due to the difficulty in finding overlapping episodes of early life trauma and an orthogonal natural experiment that changed the incentives for investing in children.

Our study takes a step toward filling this gap. Our results demonstrate a strong protective effect of one-time vitamin A supplementation at birth. We interpret this protection as evidence that, at least in very early life, endowments (as proxied for by tornado exposure) and investments (vitamin A) are substitutes. Whether this remains true when outcomes are measured in later childhood and adulthood is an open question. Although our findings hold up to various robustness checks and are consistent across a diverse set of outcomes (anthropometry, fever incidence and mortality), their strength is somewhat limited by the relatively small share of infants in the study affected by the tornado. Our results hopefully offer a valuable start and suggest that more research on the role of micronutrient deficiencies in infants' resilience to shocks is likely to be very valuable.

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Table 1: **Summary Statistics of Infants in the Pre-tornado Cohorts**

									Within Tornado Area					
	All N = 5269		**Tornado N = 345**		**Non-tornado N = 4924**		**Difference**		**Vitamin A N = 184**		**Placebo N = 161**		**Difference**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SE	Mean	SD	Mean	SD	Mean	SE
Infant birth anthropometry														
Weight (kg)	2.49	0.43	2.51	0.41	2.49	0.43	0.02	0.03	2.54	0.38	2.49	0.43	0.04	0.06
Height (cm)	46.67	2.35	46.61	2.23	46.68	2.36	−0.06	0.17	46.80	2.09	46.40	2.37	0.40	0.31
MUAC (cm)	9.44	0.85	9.48	0.81	9.43	0.85	0.04	0.06	9.50	0.73	9.44	0.89	0.06	0.11
Head Circumference (cm)	32.67	1.62	32.73	1.71	32.67	1.61	0.06	0.12	32.82	1.58	32.63	1.84	0.19	0.24
Chest Circumference (cm)	30.74	2.10	30.77	1.96	30.73	2.11	0.03	0.15	30.80	1.74	30.73	2.18	0.07	0.27
Infant anthropometry at 3 months														
MUAC (cm)	12.38	1.06	12.43	1.07	12.37	1.06	0.05	0.06	12.43	1.02	12.42	1.14	0.01	0.12
Head Circ. (cm)	38.71	1.48	38.58	1.45	38.72	1.48	−0.14	0.09	38.51	1.33	38.67	1.59	−0.16	0.17
Chest Circumference (cm)	38.89	2.21	38.98	2.17	38.89	2.22	0.10	0.13	38.82	2.15	39.18	2.18	−0.36	0.25
Anthropometric Index	0.17	0.98	0.17	0.97	0.17	0.99	0.00	0.06	0.13	0.91	0.22	1.05	−0.09	0.11
Infant anthropometry at 6 months														
MUAC	13.09	1.04	13.20	1.06	13.09	1.04	0.11	0.06*	13.27	1.05	13.12	1.07	0.15	0.12
Head Circumference (cm)	40.89	1.41	41.01	1.38	40.88	1.42	0.13	0.08	40.97	1.41	41.05	1.36	−0.08	0.16
Chest Circumference (cm)	41.34	2.11	41.59	2.11	41.32	2.11	0.27	0.12**	41.51	2.13	41.67	2.10	−0.16	0.24
Anthropometric Index	0.04	0.99	0.16	1.00	0.03	0.98	0.13	0.06**	0.17	1.02	0.16	0.99	0.01	0.11
Other infant outcomes														
Gender is Male	0.51	0.50	0.54	0.50	0.51	0.50	0.03	0.03	0.52	0.50	0.57	0.50	−0.06	0.05
Fever Incidence, 0-3 months	0.58	0.49	0.56	0.50	0.59	0.49	−0.03	0.03	0.56	0.50	0.55	0.50	0.01	0.06
Fever Incidence 0-6 months	0.55	0.50	0.57	0.50	0.55	0.50	0.02	0.03	0.57	0.50	0.57	0.50	0.00	0.06
Mortality 0-24 weeks	0.05	0.22	0.04	0.20	0.05	0.23	−0.01	0.01	0.04	0.21	0.04	0.19	0.01	0.02
Maternal characteristics														
Parity	1.33	2.41	1.23	1.48	1.33	2.46	−0.10	0.13	1.38	1.64	1.07	1.26	0.31	0.16*
LSI	−0.04	0.99	−0.11	0.94	−0.04	0.99	−0.07	0.06	−0.09	0.97	−0.13	0.90	0.04	0.10
Height (cm)	149.32	5.15	149.01	5.08	149.34	5.16	−0.34	0.29	148.72	4.97	149.33	5.20	−0.61	0.55
MUAC (cm)	22.66	1.93	22.61	2.00	22.66	1.93	−0.05	0.11	22.58	2.08	22.65	1.91	−0.07	0.22
Education (years)	3.62	4.03	3.54	3.94	3.62	4.04	−0.08	0.22	3.92	4.26	3.11	3.50	0.81	0.42*
Dosing														
Dosed <= 6 hours	0.49	0.50	0.55	0.50	0.49	0.50	0.07	0.03**	0.50	0.50	0.62	0.49	−0.12	0.06*
Dosed <= 12 hours	0.63	0.48	0.69	0.46	0.63	0.48	0.06	0.03*	0.65	0.48	0.73	0.45	−0.07	0.06
Dosed <= 18 hours	0.71	0.45	0.75	0.43	0.71	0.46	0.04	0.03	0.71	0.45	0.80	0.40	−0.08	0.06
Dosed <= 24 hours	0.75	0.43	0.78	0.42	0.75	0.43	0.03	0.03	0.75	0.43	0.81	0.39	−0.06	0.05
Dosed <= 7 days	0.85	0.35	0.88	0.32	0.85	0.36	0.03	0.02	0.88	0.32	0.88	0.32	0.00	0.04

Summary statistics for the study sample (infant sample), limited to infants born at least 9 months before the tornado. Tornado and Non-Tornado refer to inside vs. outside the tornado area. The last three columns restrict the sample to only within the tornado area. We report OLS standard errors and associated p-values to give a general idea of the variation in the data rather than as formal hypothesis tests (which would need to take account of clustering).

Significance: * < 0.1; ** < 0.05; *** < 0.01.

Table 2: **Time to Dosing by Tornado and Treatment Status for Infants In-Utero at the Time of the Tornado**

									Within Tornado Area					
	Full sample N = 5343		**Tornado N = 346**		**Non-tornado N = 4997**		**Difference**		**Vitamin A N = 183**		**Placebo N = 163**		**Difference**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SE	Mean	SD	Mean	SD	Mean	SE
Dosing														
Dosed <= 6 hours	0.47	0.50	0.48	0.50	0.47	0.50	0.01	0.03	0.47	0.50	0.50	0.50	−0.03	0.05
Dosed <= 12 hours	0.64	0.48	0.63	0.48	0.64	0.48	0.00	0.03	0.62	0.49	0.65	0.48	−0.02	0.05
Dosed <= 18 hours	0.71	0.45	0.71	0.45	0.71	0.45	0.00	0.03	0.69	0.46	0.73	0.45	−0.04	0.05
Dosed <= 24 hours	0.75	0.43	0.75	0.43	0.75	0.43	0.01	0.02	0.74	0.44	0.77	0.42	−0.04	0.05
Dosed <= 7 days	0.84	0.36	0.85	0.36	0.84	0.36	0.00	0.02	0.82	0.38	0.87	0.33	−0.05	0.04

Summary statistics of time-to-dosing by area. Tornado and Non-tornado refer to inside vs. outside the tornado area. The last three columns restrict the sample to only within the tornado area. The sample includes only infants that were in-utero when the tornado hit (whether inside or outside the affected area).
Significance: * < 0.1; ** < 0.05; *** < 0.01.

Table 3: **Attrition at birth, 3 months and 6 months**

	Birth measures		3 month measures		6 month measures	
	Missing	Missing or late	Missing Missing	Missing or late	Missing	Missing or late
	b/se	b/se	b/se	b/se	b/se	b/se
Triple interaction: In tornado area X Vit A X ..						
0-270 days after LMP	-0.00	0.04	-0.00	-0.01	-0.04	-0.05
	(0.04)	(0.06)	(0.04)	(0.04)	(0.05)	(0.05)
271-360 days after LMP			0.00	0.00	0.01	0.00
			(0.06)	(0.06)	(0.06)	(0.07)
361-450 days after LMP					-0.01	-0.04
					(0.06)	(0.06)
Double interaction: In tornado area X ..						
0-270 days after LMP	0.04	0.00	0.03	0.03	0.07**	0.07**
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
271-360 days after LMP			-0.01	-0.02	-0.00	0.00
			(0.04)	(0.04)	(0.04)	(0.05)
361-450 days after LMP					-0.01	-0.00
					(0.05)	(0.05)
Double interaction: Vit A X ..						
0-270 days after LMP	-0.00	0.00	0.01	0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
271-360 days after LMP			0.03*	0.04**	0.02	0.02
			(0.02)	(0.02)	(0.02)	(0.02)
361-450 days after LMP					0.00	-0.00
					(0.02)	(0.02)
Cohorts:						
0-270 days after LMP	-0.12***	-0.10***	-0.03***	-0.03***	-0.02***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
271-360 days after LMP			-0.03**	-0.03***	-0.02*	-0.02*
			(0.01)	(0.01)	(0.01)	(0.01)
361-450 days after LMP					-0.00	-0.00
					(0.01)	(0.01)
Observations	18872	18872	18872	18872	18872	18872

Attrition in the data by cohort. The dependent variable in columns 1, 3 and 5 is a dummy indicating missing values for birth anthropometry, 3-month anthropometry and 6 month-anthropometry. The dependent variable in columns 2, 4, and 6 is the same as the odd columns except that infants measured late (after 7 days for birth anthropometry, or 8 weeks after the target date for 3 and 6 month anthropometry) are also coded as 1. Our main outcome measures used in the paper are set to missing after these cutoff dates so the even numbered columns correspond to the attrition for those main outcome measures. Because or normal cohort definitions (used throughout the paper) rely on the birthdate (which is missing for many of the infants that attrit) we use alternative cohort definitions in this table where we count the days since the last menstrual period to fit approximately the in-utero (0-270 days), first three months (271-360 days) and 3-6 month (361-450 days) periods. Standard errors are clustered at the sector (treatment randomization) level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 4: **Contingency Table of Tornado Damage by Treatment Status**

	Share of houses destroyed					
	0-20%	21-40%	41-60%	61-80%	81-100%	Total
Control (# of sectors):	6	4	1	3	6	20
Vitamin A (# of sectors):	11	1	2	7	0	21
All tornado damaged sectors						
Average Control:	47.6%					
Average Vitamin A:	33.7%					
Vitamin A - Control	= -14%					
Excluding sectors with > 80% damage						
Average Control:	28.7%					
Average Vitamin A:	33.5%					
Vitamin A - Control :	= 5%					

Tornado damage (share of houses destroyed) by treatment allocation (within sectors with any damage).

Table 5: **The effect of tornado exposure and maternal supplementation on birth outcomes**

	BW b/se	log(BW) b/se	LBW b/se	BGGA b/se	PM b/se	SMGA b/se	Height b/se	MUAC b/se	HC b/se	CC b/se	BirthAI b/se
In tornado area X In utero	-0.13**	-0.05**	0.15*	-0.38	0.04	0.03	-0.55**	-0.25**	-0.47*	-0.29	-0.27**
	(0.06)	(0.02)	(0.08)	(0.35)	(0.04)	(0.04)	(0.23)	(0.12)	(0.27)	(0.19)	(0.13)
In tornado area X In utero X Maternal supplementation	0.03	0.01	-0.04	0.52	-0.06	0.06	-0.06	0.06	0.10	0.07	0.04
	(0.07)	(0.03)	(0.09)	(0.44)	(0.05)	(0.06)	(0.34)	(0.15)	(0.34)	(0.25)	(0.16)
In utero X Maternal supplementation	0.01	0.01	0.00	-0.13	0.04**	-0.02	-0.05	0.01	-0.01	0.01	0.01
	(0.02)	(0.01)	(0.02)	(0.12)	(0.02)	(0.02)	(0.12)	(0.04)	(0.10)	(0.07)	(0.05)
In utero	0.01	0.00	-0.01	0.45***	-0.07***	-0.00	0.32***	-0.05	-0.01	0.01	0.02
	(0.02)	(0.01)	(0.02)	(0.09)	(0.02)	(0.01)	(0.10)	(0.03)	(0.08)	(0.06)	(0.04)
Age at newborn anthropometry	-0.01**	-0.00***	0.01*	-0.00	0.00	-0.00***	0.05**	-0.08***	-0.06***	0.08***	-0.02**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Constant	2.44***	0.88***	0.54***	37.61***	0.29***	0.26***	46.36***	9.38***	30.46***	32.32***	0.03***
	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
Observations	13884	13884	13884	16750	16750	16259	13521	13788	13660	13769	13897

Linear regression models of birth outcomes as a function of tornado exposure in utero, interacted with vitamin A or β-carotene supplementation of the mother (we combine the vitamin A and β-carotene supplementation groups as they are similar and had similar effects (β-carotene can be converted into vitamin A by the body)). The sample includes only live born singleton infants. BW is birth weight in kilograms. log(BW) is the log of birth weight. LBW is an indicator for birth weight < 2.5kg. GA is our measure of gestational age. PM is an indicator for prematurity (gestational age < 37 weeks). Small for Gestational Age (SMGA) is an indicator that is equal to 1 if the infant is below the 25th percentile in weight given gestational age (for this sample). Height, mid-upper arm circumference (MUAC), head circumference (HC) and chest circumference are measured in centimeters. BirthAI is an index constructed as the standardized (0 mean, 1 SD) average of standardized values of: birth weight, birth height, birth MUAC, birth HC and birth CC. Standard errors are clustered at the sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 6: **Difference-in-Difference Table: Anthropometric index at 3 months.**

	Not in Tornado Window		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	-0.00	-0.01	-0.01 (0.02)
In Tornado Area	0.14	0.09	-0.06 (0.08)
Difference	0.14 (0.05)***	0.10 (0.06)*	-0.05 (0.08)
	In utero at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	-0.01	-0.00	0.01 (0.04)
In Tornado Area	-0.01	0.09	0.10 (0.15)
Difference	-0.01 (0.09)	0.09 (0.12)	0.10 (0.15)
	In first 10 weeks at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	0.01	-0.02	-0.03 (0.05)
In Tornado Area	-0.10	0.13	0.23 (0.16)
Difference	-0.11 (0.14)	0.15 (0.08)*	0.26 (0.16)
Difference in-utero	-0.15 (0.10)	-0.01 (0.13)	0.14 (0.16)
Difference in first 10 weeks	-0.26 (0.14)*	0.05 (0.10)	0.31 (0.18)*

The table shows means and differences (along with standard errors of differences) for the various subsamples that define the triple-difference strategy: within vs. outside the tornado area; within versus outside the tornado window (i.e. in utero or in first 10 weeks of life at the time of tornado) and in treatment versus control sectors. The outcome variable is the anthropometric index (standardized average of MUAC, head circumference and chest circumference) measured at 3 months of age (the index SD is 1). Standard errors are clustered at the sector (vitamin A randomization) level. Significance: * < 0.1; ** < 0.05; *** < 0.01.

Table 7: **Difference-in-Difference Table: Anthropometric index at 6 months.**

	Not in Tornado Window		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	0.01	-0.00	-0.01 (0.03)
In Tornado Area	0.18	0.14	-0.04 (0.07)
Difference	0.17 (0.06)***	0.15 (0.05)***	-0.03 (0.08)
	In utero at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	-0.02	-0.02	-0.01 (0.04)
In Tornado Area	0.08	0.17	0.09 (0.12)
Difference	0.09 (0.06)*	0.19 (0.11)*	0.09 (0.12)
	In first 22 weeks at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	-0.02	-0.02	-0.01 (0.04)
In Tornado Area	-0.06	0.17	0.23 (0.12)*
Difference	-0.04 (0.10)	0.20 (0.08)**	0.24 (0.13)*
Difference in-utero	-0.08 (0.07)	0.04 (0.10)	0.12 (0.12)
Difference in first 22 weeks	-0.21 (0.10)**	0.05 (0.09)	0.26 (0.14)*

The table shows means and differences (along with standard errors of differences) for the various subsamples that define the triple-difference strategy: within vs. outside the tornado area; within versus outside the tornado window (i.e. in utero or in first 22 weeks of life at the time of tornado) and in treatment versus control sectors. The outcome variable is the anthropometric index (standardized average of MUAC, head circumference and chest circumference) measured at 6 months of age (the index SD is 1). Standard errors are clustered at the sector (vitamin A randomization) level. Significance: * < 0.1; ** < 0.05; *** < 0.01.

Table 8: **Anthropometry at 3 months: Main specification (triple-difference).**

	AI		MUAC		CC		HC	
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Triple interaction: In tornado area X Vit A X ..								
In utero	0.20	0.17	0.22	0.20	0.43	0.40	0.20	0.17
	(0.15)	(0.15)	(0.15)	(0.15)	(0.38)	(0.36)	(0.23)	(0.22)
0-10 weeks of age	0.41**	0.32*	0.44**	0.34*	0.87**	0.74*	0.38	0.30
	(0.19)	(0.19)	(0.19)	(0.19)	(0.43)	(0.43)	(0.28)	(0.27)
Double interaction: In tornado area X ..								
In utero	-0.17	-0.12	-0.19*	-0.14	-0.52*	-0.40	-0.07	-0.01
	(0.11)	(0.10)	(0.10)	(0.09)	(0.27)	(0.25)	(0.18)	(0.17)
0-10 weeks of age	-0.31**	-0.30**	-0.33**	-0.30**	-0.87**	-0.85**	-0.16	-0.15
	(0.15)	(0.15)	(0.15)	(0.15)	(0.36)	(0.37)	(0.22)	(0.20)
Double interaction: Vit A X ..								
In utero	0.01	0.02	-0.01	-0.01	0.05	0.06	0.05	0.06
	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.08)	(0.05)	(0.05)
0-10 weeks of age	-0.02	-0.02	-0.05	-0.04	-0.06	-0.07	0.05	0.06
	(0.05)	(0.05)	(0.06)	(0.06)	(0.13)	(0.12)	(0.08)	(0.08)
Cohorts:								
In utero	-0.03	-0.05**	-0.03	-0.06**	0.01	-0.04	-0.08**	-0.11***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.04)	(0.04)
0-10 weeks of age	0.05	0.04	0.06	0.05	0.05	0.04	0.04	0.03
	(0.04)	(0.03)	(0.04)	(0.04)	(0.09)	(0.08)	(0.06)	(0.06)
- Other controls -								
Best guess length of gestation (weeks)	0.06***	0.05***	0.05***	0.04***	0.13***	0.11***	0.09***	0.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.02***	0.02***	0.02***	0.02***	0.04***	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Maternal MUAC		0.06***		0.07***		0.13***		0.06***
		(0.00)		(0.00)		(0.01)		(0.01)
Maternal height		0.03***		0.03***		0.07***		0.04***
		(0.00)		(0.00)		(0.00)		(0.00)
Living Standards Index		0.10***		0.10***		0.21***		0.11***
		(0.01)		(0.01)		(0.02)		(0.01)
Observations	16490	16467	16471	16448	15970	15950	16449	16426

Linear regression models of infant development measured by anthropometry at 3 months. The outcome variables are mid-upper arm circumference (MUAC), head circumference (HC) and chest circumference (CC), all measured in centimeters and an anthropometric index (AI) that is a standardized (zero mean, unit SD) average of the three variables after each has been standardized to zero mean and unit standard deviation. ”Vit A” is an indicator that is 1 if infants in the sector were given vitamin A and zero if they were in the placebo group. ”In Tornado Area” is an indicator defined as 1 if any households in the sector were destroyed in the tornado. ”In utero” is an indicator that is 1 if the infant was in utero at the date of the tornado and ”0-10 weeks of age” is 1 if the infant was in his or her first 10 weeks of life at the date of the tornado. Combined these three types of indicators define our triple difference strategy. Each regression contains randomization sector fixed effects (this absorbs main effects of the tornado area and treatment indicators). Living Standards is an index based on a principal components analysis of household assets. Best guess gestational length is based on date of last menstrual period reported at enrollment in the study (in the first trimester). Standard errors are clustered at the sector (treatment randomization) level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 9: **Anthropometry at 6 months: Main specification (triple-difference).**

	AI		MUAC		CC		HC	
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Triple interaction: In tornado area X Vit A X ..								
In utero	0.17	0.14	0.28*	0.26*	0.25	0.20	0.08	0.04
	(0.13)	(0.12)	(0.14)	(0.14)	(0.29)	(0.27)	(0.20)	(0.20)
0-10 weeks of age	0.52***	0.42**	0.67***	0.56***	0.71*	0.54	0.57**	0.47*
	(0.18)	(0.18)	(0.17)	(0.17)	(0.42)	(0.39)	(0.27)	(0.26)
11-22 weeks of age	0.12	0.13	0.28	0.29	0.19	0.22	-0.06	-0.06
	(0.19)	(0.20)	(0.20)	(0.22)	(0.38)	(0.40)	(0.27)	(0.28)
Double interaction: In tornado area X ..								
In utero	-0.10	-0.04	-0.11	-0.07	-0.20	-0.10	-0.07	-0.01
	(0.08)	(0.07)	(0.09)	(0.09)	(0.18)	(0.16)	(0.13)	(0.13)
0-10 weeks of age	-0.34**	-0.31**	-0.40***	-0.37***	-0.62*	-0.58*	-0.26	-0.24
	(0.14)	(0.13)	(0.12)	(0.11)	(0.33)	(0.30)	(0.22)	(0.20)
11-22 weeks of age	-0.15	-0.16	-0.26*	-0.28*	-0.38	-0.41*	0.09	0.09
	(0.13)	(0.13)	(0.15)	(0.15)	(0.24)	(0.24)	(0.19)	(0.19)
Double interaction: Vit A X ..								
In utero	0.00	0.01	-0.04	-0.03	0.02	0.04	0.04	0.05
	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.09)	(0.06)	(0.06)
0-10 weeks of age	-0.04	-0.03	-0.11*	-0.11*	-0.10	-0.11	0.07	0.08
	(0.06)	(0.05)	(0.06)	(0.06)	(0.13)	(0.12)	(0.09)	(0.09)
11-22 weeks of age	-0.00	0.00	-0.02	-0.02	-0.03	-0.04	0.05	0.06
	(0.05)	(0.05)	(0.05)	(0.05)	(0.12)	(0.11)	(0.07)	(0.07)
Cohorts:								
In utero	-0.03	-0.07**	-0.06*	-0.09***	0.04	-0.03	-0.04	-0.08*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.04)	(0.04)
0-10 weeks of age	0.05	0.04	0.04	0.03	0.13	0.11	0.02	0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.08)	(0.06)	(0.06)
11-22 weeks of age	-0.06	-0.07*	-0.10***	-0.11***	-0.14*	-0.16**	-0.01	-0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.05)	(0.05)
- Other controls -								
Best guess length of gestation (weeks)	0.04***	0.03***	0.03***	0.02***	0.08***	0.06***	0.05***	0.04***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Age at 6 month measurement (centered)	0.01***	0.01***	0.00***	0.00***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Maternal MUAC		0.07***		0.08***		0.15***		0.06***
		(0.00)		(0.00)		(0.01)		(0.01)
Maternal height		0.03***		0.02***		0.07***		0.04***
		(0.00)		(0.00)		(0.00)		(0.00)
Living Standards Index		0.12***		0.12***		0.25***		0.11***
		(0.01)		(0.01)		(0.02)		(0.01)
Observations	16226	16202	16211	16187	15578	15555	16118	16094

Linear regression models of infant development measured by anthropometry at 6 months. The outcome variables are mid-upper arm circumference (MUAC), head circumference (HC) and chest circumference (CC), all measured in centimeters and an anthropometric index (AI) that is a standardized (zero mean, unit SD) average of the three variables after each has been standardized to zero mean and unit standard deviation. "Vit A" is an indicator that is 1 if infants in the sector were given vitamin A and zero if they were in the placebo group. "In Tornado Area" is an indicator defined as 1 if any households in the sector were destroyed in the tornado. "In utero" is an indicator that is 1 if the infant was in utero at the date of the tornado and "0-10 weeks of age" is 1 if the infant was in his or her first 10 weeks of life at the date of the tornado. Combined these three types of indicators define our triple difference strategy. Each regression contains randomization sector fixed effects (this absorbs main effects of the tornado area and treatment indicators). Living Standards is an index based on a principal components analysis of household assets. Best guess gestational length is based on date of last menstrual period reported at enrollment in the study (in the first trimester). Standard errors are clustered at the sector (treatment randomization) level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 10: **Difference-in-Difference Table: Fever episodes at 0-3 months.**

	Not in Tornado Window		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	0.92	0.91	-0.01 (0.02)
In Tornado Area	0.89	0.92	0.03 (0.09)
Difference	-0.03 (0.07)	0.01 (0.05)	0.04 (0.09)
	In utero at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	0.87	0.87	-0.01 (0.04)
In Tornado Area	1.10	1.21	0.11 (0.18)
Difference	0.22 (0.11)**	0.34 (0.15)**	0.12 (0.18)
	In first 10 weeks at tornado		
	Placebo	Vitamin A	Difference (VA-PL)
	b (se)	b (se)	b (se)
Not in Tornado Area	0.86	0.88	0.02 (0.06)
In Tornado Area	1.34	0.88	-0.46 (0.25)*
Difference	0.48 (0.19)**	-0.01 (0.16)	-0.48 (0.25)*
Difference in-utero	0.26 (0.11)**	0.34 (0.14)**	0.08 (0.18)
Difference in first 10 weeks	0.51 (0.16)***	-0.01 (0.16)	-0.52 (0.23)**

The table shows means and differences (along with standard errors of differences) for the various subsamples that define the triple-difference strategy: within vs. outside the tornado area; within versus outside the tornado window (i.e. in utero or in first 10 weeks of life at the time of tornado) and in treatment versus control sectors. The outcome variable is number of fever episodes in the first 3 months top coded at 4 (> 4 episodes are set to 4). Standard errors are clustered at the sector (vitamin A randomization) level. Significance: * < 0.1; ** < 0.05; *** < 0.01.

Table 11: **Incidence of fever: main specification (triple-difference)**

	In months 0-3		In months 4-6	
	Any fever b/se	Num. episodes b/se	Any fever b/se	Num. episodes b/se
Triple interaction: In tornado area X Vit A X ..				
In utero	0.00	0.05	-0.03	0.03
	(0.07)	(0.18)	(0.08)	(0.17)
0-3 months of age	-0.14	-0.39**	-0.05	-0.18
	(0.10)	(0.19)	(0.10)	(0.27)
4-6 months of age			-0.01	-0.11
			(0.09)	(0.24)
Double interaction: In tornado area X ..				
In utero	0.07	0.33***	0.05	0.16
	(0.05)	(0.11)	(0.05)	(0.12)
0-3 months of age	0.22***	0.53***	0.10	0.44**
	(0.07)	(0.12)	(0.07)	(0.21)
4-6 months of age			0.05	0.42**
			(0.08)	(0.17)
Double interaction: Vit A X ..				
In utero	-0.03	0.02	0.00	-0.02
	(0.02)	(0.04)	(0.02)	(0.04)
0-3 months of age	-0.04	0.00	0.03	0.00
	(0.03)	(0.05)	(0.03)	(0.06)
4-6 months of age			0.01	-0.02
			(0.03)	(0.05)
Cohorts:				
In utero	-0.00	-0.06**	0.02	0.04
	(0.01)	(0.03)	(0.01)	(0.03)
0-3 months of age	-0.01	-0.06*	0.03	0.09**
	(0.02)	(0.03)	(0.02)	(0.04)
4-6 months of age			0.01	0.05
			(0.02)	(0.04)
- Other controls -				
Best guess length of gestation (weeks)	0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.00***	0.01***		
	(0.00)	(0.00)		
Age at 6 month measurement (centered)			-0.00	-0.00
			(0.00)	(0.00)
Observations	16885	16776	16764	16598

Linear regression models of fever using our main specifications. The outcome variables of fever episodes in 0-3 months and 4-6 months are top coded at 4 (>4 episodes are coded as 4).
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 12: **Robustness of key regressions to defining a post-tornado cohort.**

	AI		MUAC		Fever	
	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se
Triple int.: In tornado area X Vit A X ..						
Conceived after tornado	0.04	-0.13	-0.02	-0.21	-0.01	0.04
	(0.13)	(0.15)	(0.15)	(0.17)	(0.17)	(0.20)
In utero	0.20	0.11	0.21	0.19	0.04	0.03
	(0.16)	(0.15)	(0.17)	(0.17)	(0.19)	(0.17)
0-10 weeks of age	0.42**	0.47**	0.43**	0.58***	-0.47*	-0.21
	(0.20)	(0.19)	(0.20)	(0.18)	(0.24)	(0.27)
11-22 weeks of age		0.06		0.19		-0.16
		(0.20)		(0.22)		(0.26)
Double interaction: In tornado area X ..						
Conceived after tornado	0.23***	0.19*	0.22***	0.14	-0.04	-0.13
	(0.08)	(0.11)	(0.09)	(0.13)	(0.11)	(0.15)
In utero	-0.09	-0.01	-0.11	-0.05	0.29***	0.11
	(0.11)	(0.10)	(0.11)	(0.12)	(0.11)	(0.14)
0-10 weeks of age	-0.24	-0.26*	-0.25	-0.34***	0.45**	0.37*
	(0.16)	(0.15)	(0.16)	(0.12)	(0.18)	(0.22)
11-22 weeks of age		-0.07		-0.20		0.49***
		(0.15)		(0.17)		(0.18)
Double interaction: Vit A X ..						
Conceived after tornado	-0.04	-0.06	-0.03	-0.06	0.02	0.02
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
In utero	-0.00	-0.02	-0.02	-0.07	0.02	-0.01
	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Age 0-10 weeks	-0.04	-0.06	-0.06	-0.13**	0.01	0.02
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Age 11-22 weeks		-0.03		-0.05		-0.00
		(0.06)		(0.06)		(0.06)
Cohorts:						
Conceived after tornado	-0.07**	-0.02	-0.05	-0.02	0.23***	0.17***
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
In utero	-0.05*	-0.04	-0.05	-0.06*	0.02	0.11***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Age 0-10 weeks	0.02	0.04	0.04	0.04	0.05	0.17***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Age 11-22 weeks		-0.07*		-0.11***		0.13***
		(0.04)		(0.04)		(0.04)
- Other controls -						
Best guess length of gestation (weeks)	0.06***	0.04***	0.05***	0.03***	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.02***		0.02***		0.01***	
	(0.00)		(0.00)		(0.00)	
Age at 6 month measurement (centered)		0.01***		0.00***		0.00
		(0.00)		(0.00)		(0.00)
Observations	16490	16226	16471	16211	16776	16598

Linear regression models of anthropometric growth and fever incidence using specifications similar to our main specifications except that we add a new cohort of those that were conceived after the tornado time (by our best guess). Using this specification the comparison (reference) group includes only infants born more than 2.5 months before the tornado (5.5 months in even numbered columns). Standard errors are clustered at the sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 13: **Key regressions using two-way clustering**

	AI		MUAC		Fever	
	3 Mo.	6 Mo.	3 Mo.	6 Mo.	3 Mo.	6 Mo.
	b/se	b/se	b/se	b/se	b/se	b/se
Triple int.: In tornado area X Vit A X ..						
Conceived after tornado	0.04	-0.13	-0.02	-0.21	-0.01	0.04
	(0.13)	(0.15)	(0.15)	(0.17)	(0.17)	(0.20)
In utero	0.20	0.11	0.21	0.19	0.04	0.03
	(0.16)	(0.15)	(0.17)	(0.17)	(0.19)	(0.17)
0-10 weeks of age	0.42**	0.47**	0.43**	0.58***	-0.47*	-0.21
	(0.20)	(0.19)	(0.20)	(0.18)	(0.24)	(0.27)
11-22 weeks of age		0.06		0.19		-0.16
		(0.20)		(0.22)		(0.26)
Double interaction: In tornado area X ..						
Conceived after tornado	0.23***	0.19*	0.22***	0.14	-0.04	-0.13
	(0.08)	(0.11)	(0.09)	(0.13)	(0.11)	(0.15)
In utero	-0.09	-0.01	-0.11	-0.05	0.29***	0.11
	(0.11)	(0.10)	(0.11)	(0.12)	(0.11)	(0.14)
0-10 weeks of age	-0.24	-0.26*	-0.25	-0.34***	0.45**	0.37*
	(0.16)	(0.15)	(0.16)	(0.12)	(0.18)	(0.22)
11-22 weeks of age		-0.07		-0.20		0.49***
		(0.15)		(0.17)		(0.18)
Double interaction: Vit A X ..						
Conceived after tornado	-0.04	-0.06	-0.03	-0.06	0.02	0.02
	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
In utero	-0.00	-0.02	-0.02	-0.07	0.02	-0.01
	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Age 0-10 weeks	-0.04	-0.06	-0.06	-0.13**	0.01	0.02
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Age 11-22 weeks		-0.03		-0.05		-0.00
		(0.06)		(0.06)		(0.06)
Cohorts:						
Conceived after tornado	-0.07**	-0.02	-0.05	-0.02	0.23***	0.17***
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
In utero	-0.05*	-0.04	-0.05	-0.06*	0.02	0.11***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Age 0-10 weeks	0.02	0.04	0.04	0.04	0.05	0.17***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Age 11-22 weeks		-0.07*		-0.11***		0.13***
		(0.04)		(0.04)		(0.04)
- Other controls -						
Best guess length of gestation (weeks)	0.06***	0.04***	0.05***	0.03***	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.02***		0.02***		0.01***	
	(0.00)		(0.00)		(0.00)	
Age at 6 month measurement (centered)		0.01***		0.00***		0.00
		(0.00)		(0.00)		(0.00)
Observations	16490	16226	16471	16211	16776	16598

Linear regression models of anthropometric growth and fever incidence using our main specifications but using two-way clustered standard errors: on randomization sector and on week of birth.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 14: **Robustness of key regressions to different levels of tornado exposure.**

	AI		MUAC		Fever	
	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se
Triple: Tornado damage 0-20% X Vit A X ..						
In utero	0.24	0.12	0.17	0.15	-0.04	0.08
	(0.24)	(0.17)	(0.19)	(0.18)	(0.21)	(0.27)
Age 0-10 weeks	0.33**	0.64***	0.35**	0.51***	-0.27	-0.57
	(0.17)	(0.17)	(0.17)	(0.18)	(0.42)	(0.54)
Age 11-22 weeks		0.18		0.42		-0.60
		(0.35)		(0.36)		(0.43)
Triple: Tornado damage 20-100% X Vit A X ..						
In utero	0.26	0.24	0.32	0.42*	0.13	-0.06
	(0.21)	(0.20)	(0.24)	(0.22)	(0.30)	(0.21)
Age 0-10 weeks	0.49**	0.55**	0.55**	0.88***	-0.44	0.09
	(0.24)	(0.25)	(0.24)	(0.23)	(0.34)	(0.33)
Age 11-22 weeks		0.07		0.28		0.03
		(0.21)		(0.25)		(0.38)
Double interaction: Tornado damage 0-20% X ..						
In utero	-0.33	-0.11	-0.25	-0.07	0.33**	0.16
	(0.22)	(0.12)	(0.15)	(0.14)	(0.16)	(0.23)
Age 0-10 weeks	-0.32***	-0.56***	-0.34***	-0.46***	0.18	0.50
	(0.08)	(0.10)	(0.06)	(0.10)	(0.40)	(0.53)
Age 11-22 weeks		-0.13		-0.46		0.90**
		(0.28)		(0.30)		(0.36)
Double interaction: Tornado damage 20-100% X ..						
In utero	-0.09	-0.09	-0.16	-0.12	0.29**	0.17
	(0.10)	(0.10)	(0.13)	(0.12)	(0.13)	(0.13)
Age 0-10 weeks	-0.30	-0.26	-0.32	-0.37***	0.55***	0.38**
	(0.20)	(0.18)	(0.20)	(0.14)	(0.18)	(0.19)
Age 11-22 weeks		-0.16		-0.18		0.39*
		(0.14)		(0.17)		(0.23)
Double interaction: Vit A X ..						
In utero	0.01	0.00	-0.01	-0.04	0.02	-0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Age 0-10 weeks	-0.02	-0.04	-0.05	-0.11*	0.01	0.01
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Age 11-22 weeks		-0.00		-0.02		-0.01
		(0.05)		(0.05)		(0.05)
Cohorts:						
In utero	-0.03	-0.03	-0.03	-0.06*	-0.05*	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Age 0-10 weeks	0.05	0.05	0.06	0.04	-0.03	0.10**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Age 11-22 weeks		-0.06		-0.10***		0.07*
		(0.04)		(0.04)		(0.04)
- Other controls -						
Best guess length of gestation (weeks)	0.06***	0.04***	0.05***	0.03***	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.02***		0.02***		0.01***	
	(0.00)		(0.00)		(0.00)	
Age at 6 month measurement (centered)		0.01***		0.00***		-0.00
		(0.00)		(0.00)		(0.00)
Observations	16490	16226	16471	16211	16776	16598

Regression models of key outcome variables where exposure to the tornado is defined in two ways: 1) being in a sector where 0-20% of houses were destroyed by the tornado or 2) being in a sector where 20-100% of houses were destroyed by the tornado. Standard errors are clustered at the (randomization) sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table 15: **Robustness of key regressions to excluding the most damaged sectors.**

	AI		MUAC		Fever	
	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se	3 Mo. b/se	6 Mo. b/se
Triple interaction: In tornado area X Vit A X ..						
In utero	0.25	0.17	0.22	0.22	-0.02	-0.00
	(0.17)	(0.13)	(0.16)	(0.14)	(0.19)	(0.18)
0-10 weeks of age	0.55**	0.75***	0.54**	0.80***	-0.49*	-0.26
	(0.23)	(0.18)	(0.23)	(0.18)	(0.25)	(0.30)
11-22 weeks of age		0.13		0.29		-0.37
		(0.20)		(0.22)		(0.30)
Double interaction: In tornado area X ..						
In utero	-0.22*	-0.09	-0.18	-0.05	0.37***	0.18
	(0.13)	(0.09)	(0.11)	(0.09)	(0.13)	(0.14)
0-10 weeks of age	-0.46**	-0.57***	-0.43**	-0.53***	0.49**	0.46*
	(0.20)	(0.13)	(0.20)	(0.13)	(0.20)	(0.25)
11-22 weeks of age		-0.16		-0.27		0.74***
		(0.15)		(0.18)		(0.22)
Double interaction: Vit A X ..						
In utero	0.01	0.00	-0.01	-0.04	0.02	-0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
0-10 weeks of age	-0.02	-0.04	-0.05	-0.11*	0.01	0.01
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
11-22 weeks of age		-0.00		-0.02		-0.01
		(0.05)		(0.05)		(0.05)
Cohorts:						
In utero	-0.03	-0.03	-0.03	-0.06*	-0.05*	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
0-10 weeks of age	0.05	0.05	0.06	0.04	-0.03	0.10**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
11-22 weeks of age		-0.06		-0.10***		0.07*
		(0.04)		(0.04)		(0.04)
- Other controls -						
Best guess length of gestation (weeks)	0.06***	0.04***	0.05***	0.03***	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age at 3 month measurement (centered)	0.02***		0.02***		0.01***	
	(0.00)		(0.00)		(0.00)	
Age at 6 month measurement (centered)		0.01***		0.00***		-0.00
		(0.00)		(0.00)		(0.00)
Observations	16332	16070	16313	16055	16617	16440

Regression models of key outcome variables where we exclude the sectors that had more than 80 % of houses destroyed (which all happened to be control sectors). Standard errors are clustered at the (randomization) sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

A Growth

Here we test whether growth, in addition to levels of anthropometric outcomes, was affected. To do this, we use growth in anthropometric measures (AI, MUAC, CC, and HC) from 0 to 3 and 0 to 6 months as the outcome variables in the same specification as worked with earlier. The results of these estimations are reported in Tables A2 and A3. Growth in both periods suffers for infants exposed to the tornado in early life. Vitamin A has a significant protective effect on growth measured at 3 and 6 months. Overall, consistent with the results on levels reported above, the evidence suggests that levels as well as growth are affected by tornado exposure in early life, but that the protective effect of vitamin A is manifest for both types of anthropometric measurement.

B Low Birth Weight Infants

In this section, we test whether babies with more general disadvantage at birth–in particular, low birth weight, as defined as birth weight below 2 kg–are worse off by 3 and 6 months, and whether vitamin A supplementation at birth is able to recuperate some of this disadvantage, in the same way that it does for tornado-exposed infants.[7] Obviously, this analysis loses some of the advantages of using tornado exposure to indicate disadvantage in early life, because the tornado is plausibly exogenous. Birth weight, on the other hand, may be correlated with outcomes later in infancy for a variety of non-causal reasons. The advantage, however, is that the tornado is a very specific kind of shock, and not easily generalizable to a more general concept of disadvantage at birth, whereas birth weight is likely a good summary measure of and proxy for this concept.

To implement the analysis, we regress AI and fever episodes at 3 and 6 months on a dummy for birth weight less than 2 kg, a vitamin A treatment sector dummy, and the interaction of the two variables. We include the same controls as we do in our baseline specification.

Results are reported in Table A4. As expected, babies with low birth weight have significantly worse AI by 3 and 6 months–about 1 standard deviation lower than "normal" infants. They are also more likely to have had episodes of serious fevers in infancy. The interaction with vitamin A treatment is small and insignificantly different from 0 for AI, indicating that there is no significant mitigating impact

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[7] We chose a cutoff of 2 kg rather than the internationally used 2.5 kg because, given the very low-income study area, nearly all the infants in our sample are below 2.5 kg so the 2.5 kg partition does not generate much variation.

of vitamin A supplementation on outcomes at 3 and 6 months. On the other hand, if we look to fever episodes, by 6 months the mitigative impact of vitamin A is quite clear (column 4).

Taking this evidence together with our main results on resilience to the negative effects of a tornado, then, we see that vitamin A may not generate resilience for all types of disadvantage, but rather may protect against the negative impacts of certain types of trauma. In particular, given the mechanisms through which vitamin A acts – that is, strengthening infants' immune systems – it seems plausible that types of trauma that test or weaken the immune system are those against which vitamin A might exhibit the largest protective effects.

C Appendix Tables

Table A1: **Attrition by cohort inside and outside the tornado area**

	In tornado area								Not in tornado area							
	Pre-tornado		0-24 weeks		In-utero		Post-tornado		Pre-tornado		0-24 weeks		In-utero		Post-tornado	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Singleton births in the infant trial	209		315		340		266		3003		4331		4520		3682	
Non missing vital status at 24 weeks	208	100	315	100	339	100	266	100	2998	100	4325	100	4514	100	3682	100
At birth																
Non missing birth anthropometry	195	93	305	97	322	95	253	95	2756	92	4058	94	4289	95	3461	94
Non missing or late birth anthr.	166	79	260	83	276	81	220	83	2322	77	3409	79	3622	80	3002	82
At 3 months																
Alive at 3 months	198	95	302	96	325	96	253	95	2839	95	4084	94	4331	96	3434	93
Non missing 3 month anthropometry	191	91	290	92	306	90	241	91	2632	88	3825	88	4088	90	3288	89
Non missing or late 3 month anthr.	189	90	284	90	301	89	236	89	2597	86	3791	88	4029	89	3264	89
At 6 months																
Alive at 6 months	197	94	301	96	320	94	252	95	2819	94	4063	94	4313	95	3416	93
Non missing 6 month anthropometry	195	93	291	92	305	90	235	88	2553	85	3749	87	4015	89	3202	87
Non missing or late 6 month anthr.	193	92	289	92	304	89	235	88	2495	83	3699	85	3987	88	3194	87

The table lists the number of infants by cohort and area that were born during the trial in the first row. In subsequent rows it lists number of infants and percentage of the total that fulfill the given data requirements (e.g., having non-missing anthropometric data at birth (Row 3)). In analyses we use only singleton births (this sample is given in Row 2). Pre-tornado (Column 1) is the cohort of infants that were at least 6 months of age when the tornado hit. The next two columns are the cohorts affected by the tornado, in the first 24 weeks of life (Column 2) or in-utero (Column 3). Infants in the post-tornado cohort (Column 4) are those conceived after the tornado (based on reported last menstrual period). In Column 5 (Unknown) are infants for which we do not have enough data to determine the cohort (these are excluded from the analysis). Anthropometry at birth is considered on time if taken no later than 7 days after birth. Anthropometry at 3 and 6 months is considered on time if taken no later than 6 weeks after the target date (target date is 12 and 24 weeks, respectively).

Table A2: **Anthropometry Growth at 3 Months.**

	Δ AI		Δ MUAC		Δ CC		Δ HC	
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Triple interaction: In tornado area X Vit A X ..								
In utero	0.21	0.20	0.18	0.18	0.38	0.38	0.21	0.20
	(0.13)	(0.13)	(0.16)	(0.15)	(0.29)	(0.29)	(0.16)	(0.17)
0-10 weeks of age	0.34**	0.30*	0.34**	0.29*	0.77*	0.72*	0.19	0.17
	(0.17)	(0.17)	(0.16)	(0.16)	(0.41)	(0.41)	(0.20)	(0.19)
Double interaction: In tornado area X ..								
In utero	-0.04	-0.03	-0.03	-0.02	-0.23	-0.20	0.04	0.05
	(0.10)	(0.10)	(0.12)	(0.11)	(0.21)	(0.20)	(0.13)	(0.13)
0-10 weeks of age	-0.32***	-0.31***	-0.31***	-0.30***	-0.90***	-0.89***	-0.08	-0.08
	(0.11)	(0.11)	(0.11)	(0.11)	(0.29)	(0.30)	(0.14)	(0.13)
Double interaction: Vit A X ..								
In utero	-0.09**	-0.08**	-0.08**	-0.07*	-0.14*	-0.12	-0.10**	-0.09**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)
0-10 weeks of age	-0.10*	-0.09*	-0.10*	-0.09	-0.21*	-0.21*	-0.06	-0.06
	(0.06)	(0.06)	(0.06)	(0.06)	(0.12)	(0.12)	(0.08)	(0.08)
Cohorts:								
In utero	0.03	0.01	0.01	-0.01	0.10*	0.07	0.00	-0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.03)	(0.03)
0-10 weeks of age	0.09**	0.08**	0.07*	0.07	0.11	0.10	0.10*	0.10*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.05)	(0.05)
- Other controls -								
Best guess length of gestation (weeks)								
Age at 3 month measurement (centered)	0.03***	0.03***	0.02***	0.02***	0.04***	0.04***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Weight at birth (kg)	0.57***	0.53***	0.45***	0.41***	1.02***	0.93***	0.61***	0.58***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.10)	(0.10)	(0.06)	(0.06)
Height at birth (cm)	0.06***	0.05***	0.04***	0.03***	0.12***	0.11***	0.07***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
MUAC at birth (cm)	-0.38***	-0.39***	-0.77***	-0.77***	-0.13***	-0.14***	-0.15***	-0.15***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.02)	(0.02)
Head circumference at birth (cm)	-0.13***	-0.13***	0.06***	0.05***	0.10***	0.10***	-0.56***	-0.57***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Chest circumference at birth (cm)	-0.12***	-0.13***	0.02**	0.02**	-0.68***	-0.69***	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Maternal MUAC		0.04***		0.05***		0.07***		0.02***
		(0.00)		(0.00)		(0.01)		(0.00)
Maternal height		0.01***		0.01***		0.03***		0.01***
		(0.00)		(0.00)		(0.00)		(0.00)
Living Standards Index		0.08***		0.08***		0.16***		0.05***
		(0.01)		(0.01)		(0.02)		(0.01)
Observations	12279	12260	12268	12249	11917	11901	12252	12233

Linear regression models of anthropometric growth at 3 months using our main specifications. The outcome variables are changes in anthropometry between birth and 3 months (Δ MUAC = MUAC at 3 months - MUAC at birth) measured in centimeters. ΔAI is a standardized (zero mean, unit SD) average of the three variables (Δ MUAC, Δ CC and Δ HC) after each has been standardized to zero mean and unit standard deviation. Living Standards is an index based on a principal components analysis of household assets. Standard errors are clustered at the sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table A3: **Anthropometry Growth at 6 Months.**

	Δ AI		Δ MUAC		Δ CC		Δ HC	
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Triple interaction: In tornado area X Vit A X ..								
In utero	0.21*	0.21*	0.28*	0.29*	0.34	0.33	0.15	0.14
	(0.13)	(0.12)	(0.16)	(0.15)	(0.31)	(0.29)	(0.19)	(0.19)
0-10 weeks of age	0.43**	0.39**	0.65***	0.59***	0.39	0.32	0.46*	0.44*
	(0.18)	(0.17)	(0.20)	(0.19)	(0.47)	(0.45)	(0.23)	(0.23)
11-22 weeks of age	0.22	0.20	0.29	0.28	0.40	0.38	0.18	0.17
	(0.23)	(0.24)	(0.23)	(0.25)	(0.51)	(0.52)	(0.26)	(0.26)
Double interaction: In tornado area X ..								
In utero	-0.03	-0.02	-0.01	0.01	-0.05	-0.01	-0.09	-0.07
	(0.09)	(0.08)	(0.12)	(0.11)	(0.23)	(0.20)	(0.13)	(0.14)
0-10 weeks of age	-0.32***	-0.31***	-0.40***	-0.38***	-0.54	-0.52	-0.29	-0.28*
	(0.12)	(0.11)	(0.11)	(0.10)	(0.36)	(0.33)	(0.19)	(0.17)
11-22 weeks of age	-0.31**	-0.30**	-0.37**	-0.36*	-0.67**	-0.64**	-0.18	-0.17
	(0.14)	(0.14)	(0.17)	(0.18)	(0.30)	(0.31)	(0.15)	(0.16)
Double interaction: Vit A X ..								
In utero	-0.08*	-0.07	-0.09**	-0.08*	-0.11	-0.09	-0.08	-0.08
	(0.04)	(0.04)	(0.05)	(0.05)	(0.09)	(0.09)	(0.06)	(0.06)
0-10 weeks of age	-0.09	-0.08	-0.13**	-0.12**	-0.18	-0.18	-0.05	-0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.13)	(0.13)	(0.09)	(0.09)
11-22 weeks of age	0.04	0.04	0.02	0.02	0.05	0.05	0.08	0.08
	(0.05)	(0.05)	(0.06)	(0.06)	(0.12)	(0.11)	(0.07)	(0.07)
Cohorts:								
In utero	0.02	0.00	-0.01	-0.03	0.10	0.06	0.03	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.07)	(0.07)	(0.04)	(0.04)
0-10 weeks of age	0.09**	0.09**	0.08*	0.07*	0.18*	0.17*	0.11*	0.11*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.09)	(0.09)	(0.06)	(0.06)
11-22 weeks of age	0.03	0.02	-0.02	-0.03	0.01	0.00	0.12**	0.12**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.05)	(0.05)
- Other controls -								
Best guess length of gestation (weeks)								
Age at 6 month measurement (centered)	0.01***	0.01***	0.00***	0.00***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Weight at birth (kg)	0.48***	0.43***	0.43***	0.38***	0.96***	0.86***	0.57***	0.52***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.11)	(0.11)	(0.07)	(0.07)
Height at birth (cm)	0.05***	0.04***	0.03***	0.03***	0.10***	0.09***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
MUAC at birth (cm)	-0.39***	-0.40***	-0.79***	-0.80***	-0.23***	-0.24***	-0.17***	-0.17***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.02)	(0.02)
Head circumference at birth (cm)	-0.14***	-0.15***	0.03***	0.02**	0.09***	0.09***	-0.59***	-0.59***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Chest circumference at birth (cm)	-0.14***	-0.15***	-0.01	-0.01	-0.75***	-0.76***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Maternal MUAC		0.05***		0.06***		0.09***		0.03***
		(0.00)		(0.00)		(0.01)		(0.01)
Maternal height		0.01***		0.01***		0.03***		0.02***
		(0.00)		(0.00)		(0.00)		(0.00)
Living Standards Index		0.09***		0.11***		0.20***		0.06***
		(0.01)		(0.01)		(0.02)		(0.01)
Observations	12016	11996	12010	11990	11554	11535	11938	11918

Linear regression models of anthropometric growth at 6 months using our main specifications. The outcome variables are changes in anthropometry between birth and 3 months (Δ MUAC = MUAC at 6 months - MUAC at birth) measured in centimeters. ΔAI is a standardized (zero mean, unit SD) average of the three variables (Δ MUAC, Δ CC and Δ HC) after each has been standardized to zero mean and unit standard deviation. Living Standards is an index based on a principal components analysis of household assets. Standard errors are clustered at the sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table A4: **Vitamin Supplementation for Low Birthweight Infants**

	AI		Fever episodes	
	3 months	6 months	3 months	6 months
	b/se	b/se	b/se	b/se
Vitamin A X Birth weight < 2kg	0.03	0.00	-0.05	-0.12**
	(0.05)	(0.05)	(0.06)	(0.05)
Vitamin A	0.01	0.01	0.01	0.00
	(0.02)	(0.02)	(0.02)	(0.02)
Birth weight < 2kg	-1.19***	-0.93***	0.09**	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)
Age in days at 3 month visit	0.02***		0.00***	
	(0.00)		(0.00)	
Age in days at 6 month visit		0.01***		-0.00
		(0.00)		(0.00)
Constant	-1.78***	-1.41***	0.45***	1.01***
	(0.07)	(0.16)	(0.08)	(0.16)
Observations	14955	14631	15156	14913

Linear regression models of infant outcomes by birth weight. The outcome variables are the Anthropometric Index (AI) at 3 and 6 months (standardized average of MUAC, CC and HC) and the number of fever episodes at 3 and 6 months (top coded at 4). All regressions include sector (randomization unit) fixed effects. Standard errors are clustered at the sector level.

Significance: * < 0.10; ** < 0.05; *** < 0.01.

Table A5: **Time at dosing.**

	Dosed at				
	<= 6 hours b/se	<= 12 hours b/se	<= 18 hours b/se	<= 24 hours b/se	<= 7 days b/se
Double interaction: In tornado area X ..					
In utero	-0.05	-0.03	-0.02	-0.00	-0.01
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
0-10 weeks of age	-0.00	0.00	0.05	0.05	0.02
	(0.06)	(0.06)	(0.05)	(0.05)	(0.03)
Cohorts:					
In utero	0.00	0.01	-0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
0-10 weeks of age	-0.05***	-0.05***	-0.04***	-0.03***	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.47***	0.63***	0.71***	0.75***	0.86***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	16812	16812	16812	16812	16812

Linear regression models of time at dosing using our main specifications. Standard errors are clustered at the sector level.
Significance: * < 0.10; ** < 0.05; *** < 0.01.