Civil unrest and birthweight: An exploratory analysis of the 2007/2008 Kenyan Crisis

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Abstract

For decades, Africa has been plagued by political and ethnic conflict, the health ramifications of which are often not investigated. A crisis occurred recently in Kenya following the 2007 presidential election. Ethnic violence ensued, targeting the incumbent President Kibaki's Kikuyu people. The violence occurred primarily in Nairobi and the Rift Valley of Kenya. We sought to examine the association between exposure to the 2007/2008 Kenyan Crisis and birthweight. Using the 2008/2009 Kenyan Demographic and Health Survey (KDHS), we compared birth weights of infants *in utero* or not yet conceived during the 15 months after the political turmoil following the 2007 presidential election (exposed) to those who were born before the crisis (unexposed). There were 663 "exposed" and 687 "unexposed" infants. Multivariate regression was used. We examined the possibility of two-way and three-way interactions between exposure status, ethnicity (Kikuyu versus non-Kikuyu), and region (violent region versus not). Overall, exposure to the Kenyan Crisis was associated with lower birthweight. Kikuyu women living in a violent region who were exposed during their 2nd trimester had the greatest difference in birthweight in comparison to all unexposed infants: 564.4 grams lower (95% CI 285.1, 843.6). Infants of Kikuyu exposed during the 2nd trimester and living in a violent region weighed 603.6 grams less (95% CI 333.6, 873.6) than Kikuyu infants born during the unexposed period. Political unrest may have implications for the birthweight of infants, particularly among targeted populations. Given the adverse sequelae associated with lowered birth weight, these results suggest that particular attention should be paid to pregnant women and targeted ethnic groups following such events.

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Introduction

For decades, Africa has been plagued by political and ethnic conflict. One such crisis occurred recently in Kenya following a presidential election. The incumbent President, Mwai Kibaki, was declared the winner on December 27th, 2007, but supporters of the opponent, Raila Odinga of the Orange Democratic Movement, suspected electoral manipulation. Ethnic violence ensued, targeting the incumbent President Kibaki's Kikuyu people. The violence occurred primarily in Nairobi and the Rift Valley of Kenya and displaced an estimated 600,000 people. We hypothesize that the resulting disruptions—social, economic, and political—were associated with poorer health outcomes in the population, in particular, the health of pregnant women and their offspring.

Maternal stress during pregnancy or prior to conception has been associated with reduced birthweight and low or very low birthweight offspring (Borders et al., 2007; Catalano & Hartig, 2001; Eskenazi et al., 2007; Khashan et al., 2008; Lauderdale, 2006; Nasreen et al., 2010; Newton & Hunt, 1984; Nkansah-Amankra et al., 2010; Paarlberg et al., 1999; Precht et al., 2007; Rondo et al., 2003; Sable & Wilkinson, 2000; Smits et al., 2006; Wadhwa et al., 1993; Zhu et al., 2010). Zhu et al. (2010) and Wadhwa et al. (1993) found that each unit increase of prenatal life event stress was associated with a 99 gram (95% CI 60.20, 137.98) and 55 gram decrease in infant birthweight, respectively. Some studies have found an association between the death or diagnosis of a serious illness in a family member and reduced infant birthweight (Khashan et al., 2008; Precht et al., 2007). Specifically, Khashan and colleagues (2008) found that the death of a relative during pregnancy or in the 6 months prior to conception was associated with reduced infant birthweight by 27 grams (95% CI 22, 33), and Precht and colleagues (2007) found that exposure to severe life events was associated with 58 grams reduced infant birthweight.

Others have demonstrated associations between large-scale stressors, such as the events of September 11th, 2001 in the United States, and low birthweight (Catalano & Hartig, 2001; Eskenazi et al., 2007; Lauderdale, 2006; Smits et al., 2006). Eskenazi et al. (2007) found increased odds for births less than 1500 grams (OR 1.44, p=0.07) and 1500-1999 grams (OR 1.67, p=0.01), and Smits et al. (2006) found that exposure was associated with birthweights reduced by 48 grams (95% CI 13.6, 82.9). In addition, Lauderdale (2006) found that Arabic American women exposed to September 11th with ethnically distinctive infant names had 2.25 times (95% CI 1.29, 3.90) the risk of having a low birthweight infant. Unfortunately, few researchers have examined maternal stress in a low-resource setting. In Bangladesh, Nasreen and colleagues (2010) found that depressive and anxiety symptoms in pregnant women were significantly associated with increased odds of low birthweight (OR 2.24, 95% CI 1.37, 3.68 and OR 2.08, 95% CI 1.30, 3.25, respectively) (Nasreen et al., 2010).

The Kenyan Crisis provides a unique opportunity to investigate the association between a population-wide stressor—civil unrest—and infant birthweight. No existing literature has examined political violence and its association with poor pregnancy outcome in a low resource and at risk nation. The possible infrastructure disruption and limited access to basic resources as a result of the violence may further impact pregnancy outcomes. Results of this exploration may shed light on the repercussions of such events in similar settings.

The relationship between stress and lowered birthweight is biologically plausible since maternal stress can cause changes in adrenal cortisol, norepinephrine, and epinephrine, resulting in increased production of placental corticotropin-releasing hormone (CRH) (Eskenazi et al., 2007; Kalantaridou et al., 2004a, b; Lockwood, 1999; Mancuso et al., 2004; Wadhwa et al., 2001). CRH naturally increases over the course of gestation and is responsible for parturition, thus higher levels of CRH early in pregnancy can result in preterm birth or fetal growth restriction, leading to low birthweight (Eskenazi et al., 2007; Glynn et al., 2001; Hobel & Culhane, 2003; Lockwood, 1999; Mancuso et al., 2004; Tegethoff et al., 2010; Vrekoussis et al., 2010; Wadhwa et al., 2004; Wadhwa et al., 2001). Low birthweight is a leading cause of infant morbidity and mortality worldwide, affecting 5.6 percent of children in Kenya (Macro, 2010; McIntire et al., 1999; Tegethoff et al., 2010).

The aim of the present investigation is to explore whether this community stressor was associated with poorer outcomes in the pregnancies of women living in the most affected regions. Specifically, we hypothesize that pregnancy during or immediately after the Kenyan Crisis will be associated with lower birthweight infants, particularly among infants of Kikuyu women living in the high conflict regions (i.e. Nairobi and Rift Valley). There are many limitations in the data, thus it is important to consider this work as an exploration of circumstances that are tragically too common and too little studied.

Methods

We employ data from the Kenyan Demographic and Health Survey (KDHS) conducted in 2008-2009 and include all children born in the 15 months before and after the beginning of the Kenyan Crisis (December 27th, 2007 to February 28th, 2008). Survey weights were applied to the analyses to take into account the complex sampling design and estimate the demographic composition of the Kenyan population (Macro, 2010).

From a total of 6,079 children, we removed all non-singleton births (n=184), children without a recorded birthweight (n=3111), and those with a date of birth outside the range of interest (n=1434). The final sample population consisted of 1350 children.

To investigate the possibility of bias resulting from the exclusion of those without a recorded birthweight, we compared sociodemographic characteristics of those women that did and did not have an infant with a recorded birthweight. Results indicated that a higher proportion of infants that did not have a recorded birthweight had mothers with lower education and wealth compared to those with a recorded birthweight. However, a higher proportion of those with a recorded birthweight were Kikuyu compared to those that did not have a recorded birthweight. We also performed logistic regression analysis where “have birthweight” was the dependent variable in order to investigate the odds of having a recorded birthweight based on maternal demographics.

Exposed offspring were considered those born between January 2008 through March 2009, i.e. those *in utero* or not yet conceived at the time of the unrest. Unexposed infants include those born prior to the crisis, i.e., between October 2006 through December 2007. There were 663 “exposed” and 687 “unexposed” infants.

To study the possibility of differences based on timing of exposure, five categories were used: exposure during the 3rd trimester, 2nd trimester, 1st trimester, 1-6 months prior to conception, and no exposure (Figure 1). The DHS did not have the specific date of birth for infants, thus we determined the mother’s exposure period by using the infant's month of birth and assuming a nine-month pregnancy. Exposure category was based on the mother's trimester of pregnancy or number of months before pregnancy as of January, 2008.

We drew from previous literature to determine which covariates to include in our analysis. We considered the following covariates: maternal age, maternal height, maternal education, marital status, smoking status, socioeconomic status, race, parity, infant sex, previous low birthweight, and gestational age. We were not able to control for previous low birthweight or gestational age since this information was not obtained. Region, ethnicity, and residence (urban vs. rural) were also included. We recoded the eight-part region variable into a two-part violent (Nairobi and Rift Valley) vs. non-violent region variable. In addition, ethnicity was recoded as a two-part Kikuyu vs. non-Kikuyu variable.

For our dependent variable, we used a continuous birthweight variable in grams. We chose birthweight as our outcome because we had no information regarding gestational age and thus could not investigate preterm birth or small for gestational age. All birthweights were provided by recall from mothers. Based on existing literature, maternally recalled birthweight is a reliable measure, but less precise than hospital records (Boeke et al., 2011; Gofin et al., 2000; Lumey et al., 1994; Seidman et al., 1987). In addition, Gofin et al. (2000) concluded, "its use is justified when no records of birthweight are available," (Gofin et al., 2000).

STATA version 11.1 was used for data analysis (StataCorp, 2009). We conducted univariate and bivariate analyses, using a p-value of 0.20 to determine which factors to incorporate into the multivariate analyses as confounders. Using survey weights, we investigated potentially significant differences among covariate categories by exposure status through use of design-based F-tests. We examined potential differences in mean birthweight among covariate categories with STATA's survey "means" command.

We created multiple regression models for mean birthweight by exposure status, controlling for all covariates and using dummy variables for each exposure group. We tested covariates (i.e. all education categories, or all wealth index categories) one at a time using an adjusted Wald test to determine whether their contribution to the explanatory power of the model was significant. Our final model prior to investigating the presence of interaction included: maternal age, education, wealth index, Kikuyu/non-Kikuyu, violent region/nonviolent region, parity, and infant sex.

The presence of two-way and three-way interactions between exposure, Kikuyu, and violent region status was investigated. We calculated differences in birthweight for interaction groups using STATA's lincom command. We then performed Hochberg step-up step-down p-value adjustment for multiple comparison to account for the 16 hypotheses tested (one hypothesis for each combination of timing of exposure in pregnancy, ethnicity, and violent region status) (Newson, 2003). In addition, in order to compare birthweights by exposure within the subpopulation of Kikuyu women, we performed multiple regression of this subpopulation, including the interaction between exposure and region; unexposed Kikuyu women were the comparison.

Sensitivity analysis was conducted for the month of December, which contained both unexposed and exposed women. December was coded as unexposed even though children born December 27-31 were actually exposed offspring. Using a subpopulation that did not contain December, we re-ran the final regression model and compared results to the initial findings.

We investigated the rate of pregnancy wastage (i.e. terminated births, stillbirths, and miscarriages), to determine if there was an increased rate among women exposed to the Kenyan Crisis. We hypothesized that an increase in maternal stress would lead to more stillbirths and miscarriages among less viable fetuses.

Results

Examining mothers' sociodemographic and pregnancy characteristics by time period of exposure relative to pregnancy illustrated few significant differences (Table 1). Overall, the greatest proportion of the sample population was in the highest DHS designated wealth quintile and 57% had completed primary education. More than 80% of women were married and nearly 70% of the women resided in a rural area. Additionally, 21% of the women were Kikuyu and 32% lived in a violent region.

Unadjusted for possible confounders, there were no overall differences in the birthweights of children *in utero* or conceived around the time of the Kenyan Crisis compared to those born before; 3340.3 grams versus 3287.9 grams (95% CI 3264.0, 3416.5 and 3228.6, 3347.1, respectively, p=0.27) (data not shown). Conducting a similar analysis with the 5-part exposure status, results from the adjusted Wald test indicated no overall differences by period of exposure. However**,** the p-value for exposure during the 3rd trimester was significant and associated with a 131.6 grams lower birthweight compared to unexposed offspring.

In the adjusted model, controlling for maternal age, maternal education, wealth index, ethnicity, region, parity, and infant sex, we found that exposure during the 3rd trimester was significantly associated with a 127.0 grams lower birthweight (Table 2).

The two two-way interactions of Kikuyu and exposure, and violent region and exposure, were significant (p=0.09 and 0.14, respectively). The interaction between Kikuyu and violent region status was not significant, nor was the three-way interaction between exposure, Kikuyu, and violent region status. Thus our final model contained our significant covariates and both sets of significant two-way cross-product terms (Table 2).

Exposure during the 3rd trimester among Kikuyu women in a violent region was associated with an average of 333.5 grams (95% CI 156.9, 510.1) lower infant birthweight compared to unexposed infants (Table 3). Even being non-Kikuyu in a violent region during the 3rd trimester was associated with a 366.4 grams (95% CI 187.4, 545.4) lower infant birthweight. Exposure during the 3rd trimester in nonviolent regions was not associated with significant differences in birthweight, regardless of ethnicity. Exposure during the 2nd trimester among Kikuyu women in a violent region was associated with the largest difference in birthweight: 564.4 grams lower (95% CI 285.1, 843.6). Even Kikuyu women exposed in the 2nd trimester living in a nonviolent region had lower birthweight infants on average: 319.5 grams lower (95% CI 121.5, 517.6) compared to unexposed infants. Analysis of 2nd trimester exposure among non-Kikuyu women, regardless of region, indicated no significant differences in birthweight. Among those exposed in the 1st trimester, we found no significant association. Being a Kikuyu woman exposed 1-6 months prior to conception in a nonviolent region was associated with an average of 376.1 grams (95% CI 127.6, 624.6) lower infant birthweight compared to unexposed infants in the sample. And being a non-Kikuyu woman living in a nonviolent region 1-6 months prior to conception was associated with a 199.3 grams (95% CI 56.7, 341.9) lower infant birthweight, on average. There were no significant birthweight differences among women living in a violent region, regardless of ethnicity, exposed 1-6 months prior to conception.

Kikuyu offspring had lower average birthweights overall, regardless of exposure status (data not shown). Restricting the analysis to the 258 Kikuyu only, we did not find a significant relationship between lower infant birthweight and exposure to the Kenyan Crisis during the 3rd, 2nd, or 1st trimester if the woman lived in a nonviolent region in comparison to unexposed Kikuyu infants (Figure 2). However, exposure during the 1-6 months prior to conception in a nonviolent region was associated with a 319.1 gram lower infant birthweight (95% CI 16.7, 621.5) compared to unexposed Kikuyu infants. In addition, among Kikuyu exposed to the Kenyan Crisis while living in a violent region, exposure during the 2nd trimester was significantly associated with a 603.6 grams (95% CI 333.6, 873.6) lower infant birthweight; this difference was the greatest observed. Exposure during the1st trimester, 3rd trimester, and 1-6 months prior to conception among Kikuyu women living in a violent region were not significantly associated with a difference in infant birthweight, although these analyses were limited by sample size.

When we examined “have birthweight” as the dependent variable in a logistic regression model, we found significantly decreased odds of having a recorded birthweight if you lived in a violent region (OR 0.6, 95% CI 0.4, 0.9). However, being Kikuyu was significantly associated with having a recorded birthweight (OR 2.9, 95% CI 1.8, 4.5). In addition, exposure prior to conception had almost double the odds of having a recorded birthweight (OR 1.9, 95% CI 1.0, 3.5). As expected, increasing education and wealth was associated with large increases in the odds of having a recorded birthweight: among those with higher education, OR=8.7 (95% CI 2.5, 30.8), and those in the highest wealth quintile, OR=7.4 (95% CI 4.3, 12.9).

The coefficients in our model did not change substantially when we removed the month of December in sensitivity analyses. In addition, our investigation of the rate of pregnancy wastage illustrated no significant changes due to exposure status, but this analysis was limited by sample size.

Discussion

Exposure to the 2007/2008 Kenyan Crisis was significantly associated with lower average birthweight compared to mothers that were not exposed to the crisis *in utero* or prior to conception. The greatest disparities in birthweight were found among Kikuyu women living in a violent region during their 2nd trimester; this was in comparison to all unexposed women and to unexposed Kikuyu women.

Unfortunately, events like the recent Kenyan Crisis are not uncommon to Africa or the developing world at large. It is important to understand the health implications of such nationwide stressors, both direct and indirect. By investigating the link between maternal stress as a result of the Kenyan Crisis and infant birthweight, we illustrated that the health consequences of such occurrences can potentially be seen for months and even years beyond the end of the event itself. The significant associations we found between this stressful event and reduced infant birthweight, both *in utero* and prior to conception, are consistent with the vast majority of published literature (Eskenazi et al., 2007; Hobel

& Culhane, 2003; Nkansah-Amankra et al., 2010; Precht et al., 2007; Rondo et al., 2003; Sable & Wilkinson, 2000; Smits et al., 2006; Tegethoff et al., 2010; Vrekoussis et al., 2010; Wadhwa et al., 2004; Wadhwa et al., 2001; Wadhwa et al., 1993). Our major contribution is that this is the first study to investigate the association between political violence and the 'stress/poor pregnancy outcome' model in a low-resource setting.

There were limitations in using this dataset. We were unable to accurately assess gestational age so we could not examine the risk of preterm delivery or fetal growth restriction. Previous low birthweight was another variable not in the DHS dataset, thus we could not control for this aspect of women's pregnancy history.

Over half of the children in the KDHS 2008/2009 did not have a recorded birthweight. Given that this was our outcome of interest, these children were excluded from our sample, greatly limiting the sample size and possibly introducing bias. Results from our logistic analysis indicate that women living in a violent region had 40% decreased odds of having a recorded birthweight compared to those not living in a violent region. In addition, women from the lower economic quintiles and those with less education were less likely to have a recorded birthweight for their infant. This means that perhaps the most at-risk infants were not weighed, thus they were not captured in our analysis. This could have resulted in a bias towards the null hypothesis. The differences in birthweight among those in the violent regions may actually have been greater in reality, but we were unable to capture the full association.

In addition, even infants that *did* have recorded birthweights had birthweights that their mothers gave by recall, thus there is a possibility of recall bias. Accuracy also seemed to be affected since women's responses tended to heap at easy to remember numbers (e.g. 2500 grams, 3000 grams, and 3500 grams). There is particular heaping at 2500 grams, many of whom are realistically below 2500 grams. The fact that our sample had 4.7% low birthweight infants (<2500 grams) compared to 5.6% in the population can be partially attributable to this heaping effect. The lower prevalence of low birthweight could also be attributable to the bias introduced by excluding those without recorded birthweights from our sample. Despite the heaping, the distribution of maternally recalled birthweights is symmetric, lending credence to the unbiased nature of this metric.

This study was also limited by cell size. Given the number of exposure categories, the number of covariates/covariate categories, and the number of cross-products, the cell counts were very low in many instances. This limited our power to detect significance. Although all combinations of exposure, Kikuyu, and violent region statuses were associated with lower infant birthweight when compared to the unexposed offspring, the cell sizes limited precision and ability to detect statistical significance.

Unlike previous studies on birthweight following the events of September 11th, the Kenyan Crisis was not an acute event. It was difficult to isolate the specific time frame of exposure because the event lasted two months. Women may have initially been exposed in their 2nd trimester, and that exposure may have continued into their 3rd trimester. This misclassification is unbiased because each individual has an equal probability of being misclassified as exposed earlier or later in pregnancy than they actually were. Unbiased misclassification of the study exposure leads to a reduction in the observed strength of the association between the exposure and the outcome, which means that if anything, our results are biased towards the null hypothesis (Greenland, 1980). An additional limitation was the fact that we estimated each mother's period of exposure relative to pregnancy based on their infant's month of birth. The dataset did not have information on women's last menstrual period, thus our estimates do not take into account premature births. This creates another way in which women's exposure could be misclassified, potentially introducing bias into our results.

Despite not being able to measure preterm birth or small for gestational age directly, recent literature by Schempf et al. (2011) found a stronger social stress mechanism for preterm birth than for small for gestational age (Schempf et al., 2011). From these results, we could conjecture that most of the differences in infant birthweight that we found in association with exposure to the Kenyan Crisis could be attributable to the effects of preterm birth and less likely small for gestational age.

Although we found no evidence of a significant difference in the rate of pregnancy wastage, it is possible that the most at-risk women were amenorrhoeic or infertile during this period of high national stress (Kalantaridou et al., 2004b). Unfortunately, this group was not captured by our analysis and thus no conclusions could be made regarding this hypothesis. Further research should investigate whether rates of infertility and time-to-pregnancy change as a result of similar nation-wide stressors.

In spite of this study's limitations, it is a study that contributes to existing literature on the association between maternal stress and infant birthweight in a novel setting and population. Results can be used to help identify populations that are likely to be at elevated risks of poor health outcomes in similar conflicts. Results indicate that medical personnel should focus extra attention on women pregnant during and immediately after social unrest in order to minimize possible downstream effects on future generations. Efforts to encourage facility deliveries should be strengthened, and additional skilled birth attendants should be brought into the affected areas to ensure safe deliveries that are attended by trained personnel. In addition, providing women with a support system by fostering a caring environment during antenatal care appointments has the potential to mitigate the effects of stress on pregnancy outcome (Edwards et al., 1994). Further research should be done with larger sample sizes and more precise outcome metrics to confirm this association in similar, at risk populations exposed to political violence.

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Figure 1: Exposure period timeline

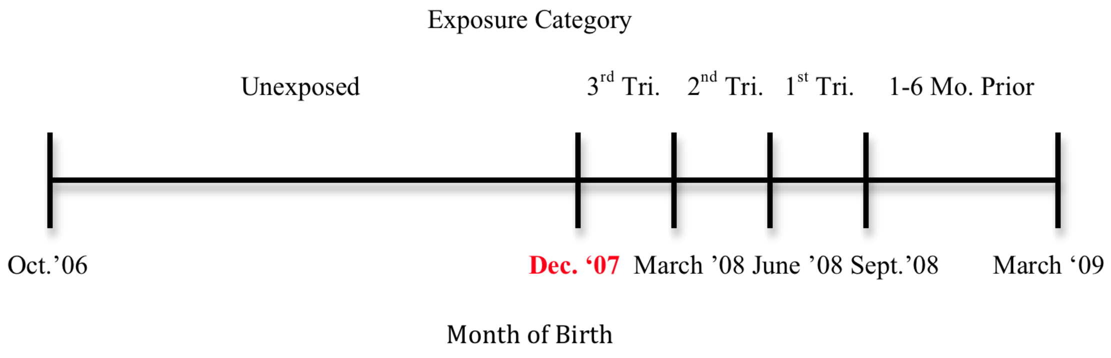

Table 1: Sociodemographic characteristics for mothers by exposure status to the Kenyan crisis, Demographic Health Survey, Kenya, 2008/2009

Characteristic	Total n (%)	Not Exposed n (%)	3rd Trimester n (%)	2nd Trimester n (%)	1st Trimester n (%)	1-6 Months Prior n (%)	Overall p-Value[a]
All	1350	687	159	209	148	166	
Maternal age (years), n (%)							
<20	136 (9.5)	62 (8.4)	13 (7.4)	26 (13.3)	18 (12.6)	17 (8.9)	0.13
20-24	445 (33.4)	218 (30.3)	47 (32.2)	73 (39.5)	53 (38.1)	54 (37.2)	
25-29	343 (24.8)	175 (24.0)	46 (31.3)	49 (22.5)	30 (22.4)	43 (27.7)	
≥30	426 (32.3)	232 (37.4)	51 (29.1)	59 (24.7)	39 (26.9)	45 (26.2)	
Maternal height, mean±SD	5.5±0.10	5.5±0.14	5.2±0.02	5.2±0.02	5.5±0.25	5.8±0.45	0.03
Maternal education, n (%)							
No education	119 (5.0)	58 (4.6)	20 (8.0)	19 (4.5)	14 (6.0)	8 (3.4)	0.81
Primary	731 (57.4)	384 (56.4)	78 (54.6)	110 (59.4)	78 (61.6)	81 (58.7)	
Secondary	357 (28.3)	175 (29.7)	41 (29.2)	60 (28.4)	33 (24.1)	48 (24.4)	
Higher	143 (9.3)	70 (9.4)	18 (8.2)	18 (7.8)	15 (8.3)	22 (13.6)	
Marital status, n (%)							
Married	1127 (83.6)	579 (84.5)	134 (83.5)	170 (83.3)	110 (77.3)	134 (83.6)	0.60
Not currently married	223 (16.4)	108 (15.5)	23 (16.6)	37 (16.7)	30 (22.7)	25 (14.8)	
Smoking, n (%)							
Yes	8 (0.4)	5 (0.6)	2 (0.4)	0 (0.0)	1 (0.7)	0 (0.0)	0.73
No	1340 (99.6)	680 (99.0)	155 (99.6)	207 (100.0)	139 (99.2)	159 (100.0)	
Wealth index, n (%)							
Poorest	182 (12.2)	92 (10.3)	21 (10.4)	22 (10.9)	27 (21.4)	20 (16.5)	0.55
Poorer	177 (15.3)	84 (15.0)	22 (14.0)	33 (17.7)	17 (13.7)	21 (16.0)	
Middle	218 (16.2)	112 (16.6)	18 (14.9)	41 (19.7)	24 (19.3)	23 (15.0)	
Richer	274 (22.7)	141 (22.9)	34 (26.2)	38 (20.1)	22 (20.5)	39 (23.8)	
Richest	499 (32.9)	258 (35.2)	62 (34.4)	73 (31.6)	50 (24.1)	56 (28.7)	
Ethnicity, n (%)							
Kikuyu	258 (20.7)	134 (21.8)	26 (16.7)	40 (21.9)	27 (17.0)	31 (22.3)	0.70
Not Kikuyu	1092 (79.3)	553 (78.2)	131 (83.5)	167 (78.4)	113 (83.6)	128 (77.7)	
Region, n (%)							
Nonviolent	1004 (68.2)	506 (66.5)	105 (64.8)	163 (70.8)	105 (75.0)	125 (69.8)	0.61
Violent	346 (31.8)	181 (33.5)	52 (35.2)	44 (29.2)	35 (25.0)	34 (30.2)	
Residence, n (%)							
Urban	528 (30.6)	269 (33.1)	65 (30.6)	82 (28.5)	48 (21.8)	64 (28.9)	0.34
Rural	822 (69.4)	418 (66.9)	92 (69.4)	125 (71.5)	92 (78.2)	95 (71.1)	
Parity							
1 child	404 (29.4)	198 (28.0)	48 (30.1)	73 (37.2)	40 (26.6)	45 (27.4)	0.28
2 children	343 (25.5)	179 (27.1)	44 (27.3)	43 (19.1)	38 (25.4)	39 (24.5)	
3 children	228 (16.9)	115 (15.3)	19 (11.4)	34 (18.6)	27 (23.8)	33 (22.4)	
4 children	140 (10.5)	78 (10.8)	12 (12.6)	18 (6.0)	10 (10.3)	22 (13.5)	
5 children	74 (5.4)	40 (6.5)	9 (5.3)	11 (3.2)	4 (1.9)	10 (5.8)	
≥6 children	161 (12.3)	77 (12.4)	25 (13.2)	28 (16.0)	21 (11.9)	10 (6.4)	
Infant sex, n (%)							
Male	697 (50.9)	746 (48.1)	87 (53.6)	106 (59.2)	74 (48.4)	81 (52.1)	0.30
Female	653 (49.1)	707 (51.9)	70 (46.6)	101 (40.8)	66 (51.6)	78 (47.9)	

[a] Adjusted Wald Test, design-based F-statistic

Table 2: Multiple linear regression models for birthweight in grams, Demographic Health Survey, Kenya, 2008/2009

	Model 1		Model 2		Model 3	
Characteristics	β (grams)	95% CI	β (grams)	95% CI	β (grams)	95% CI
Exposure status						
Unexposed		Reference		Reference		Reference
3rd trimester	-128.1	(-244.6, -11.7)	-127.0	(-243.6, -10.4)	-171.9	(-338.1, -5.7)
2nd trimester	-50.5	(-171.3, 70.3)	-50.4	(-170.4, 69.7)	-17.0	(-159.9, 125.9)
1st trimester	-63.8	(-210.4, 82.8)	-61.3	(-208.3, 85.7)	-137.9	(-311.8, 36.0)
1-6 months prior	-101.6	(-250.8, 47.7)	-100.3	(-248.7, 48.1)	-199.3	(-341.9, -56.7)
Maternal height	0.01	(-0.2, 0.0)	--	--	--	--
Maternal age (years)						
<20		Reference		Reference		Reference
20-24	-316.8	(-499.5, -134.1)	-315.8	(-499.4, -132.3)	-310.4	(-494.3, -126.5)
25-29	-270.7	(-490.5, -50.9)	-266.8	(-487.0, -46.6)	-263.8	(-485.5, -42.1)
≥30	-303.4	(-508.7, -98.1)	-298.6	(-506.0, -91.2)	-294.3	(-499.9, -88.6)
Maternal education						
No education		Reference		Reference		Reference
Primary	172.6	(-68.0, 413.3)	175.2	(-65.1, 415.5)	172.9	(-63.1, 408.9)
Secondary	231.5	(-27.5, 490.6)	233.5	(-26.5, 493.6)	227.6	(-26.2, 481.4)
Higher	106.6	(-176.2, 389.4)	109.2	(-174.4, 392.8)	96.7	(-178.0, 371.4)
Marital status						
Not currently married		Reference				
Married	5.1	(-110.5, 120.7)	--	--	--	--
Smoking						
No		Reference				
Yes	198.2	(-502.2, 898.6)	--	--	--	--
Wealth index						
Poorest		Reference		Reference		Reference
Poorer	-181.4	(-397.8, 35.1)	-185.4	(-400.4, 29.7)	-184.1	(-399.4, 31.2)
Middle	-83.5	(-243.8, 76.8)	-85.7	(-245.6, 74.2)	-95.0	(-254.5, 64.6)
Richer	-212.1	(-396.4, -27.8)	-219.6	(-399.4, -393.8)	-217.6	(-389.9, -45.4)
Richest	-72.7	(-245.1, 99.6)	-88.7	(-237.0, 59.6)	-83.1	(-230.6, 64.5)
Ethnicity						
Not Kikuyu		Reference		Reference		Reference
Kikuyu	-137.5	(-238.8, -36.2)	-137.5	(-238.9, -36.1)	-118.1	(-264.2, 28.0)
Region						
Nonviolent		Reference		Reference		Reference
Violent	-181.2	(-290.6, -71.7)	-181.4	(-291.7, -71.1)	-256.3	(-395.0, -117.7)
Residence						
Urban		Reference				
Rural	21.5	(-96.5, 139.6)	--	--	--	--
Parity						
1 child		Reference		Reference		Reference
2 children	128.8	(6.7, 250.8)	127.6	(6.6, 248.6)	125.7	(8.0, 243.4)
3 children	306.7	(168.4, 445.0)	307.6	(170.6, 444.5)	291.6	(156.0, 427.2)
4 children	69.2	(-82.6, 221.0)	69.3	(-83.3, 221.9)	51.0	(-93.2, 195.2)
5 children	113.0	(-89.0, 315.0)	114.1	(-89.0, 317.3)	117.0	(-83.9, 317.9)
≥6 children	272.8	(69.4, 476.3)	272.8	(77.1, 468.5)	275.9	(84.5, 467.2)
Infant sex						
Male		Reference		Reference		Reference
Female	-182.4	(-265.1, -99.7)	-183.9	(-267.4, -100.5)	-182.6	(-265.2, -100.0)
2-way exposure/ethnicity cross-product						
Unexposed						Reference
3rd trimester/Kikuyu	--	--	--	--	151.1	(-72.1, 374.3)
2nd trimester/Kikuyu	--	--	--	--	-184.4	(-441.2, 72.3)
1st trimester/Kikuyu	--	--	--	--	35.6	(-325.3, 396.4)
1-6 months prior/Kikuyu	--	--	--	--	-58.6	(-336.4, 219.2)
2-way exposure/region cross-product						
Unexposed						Reference
3rd trimester/violent	--	--	--	--	61.8	(-163.9, 287.5)
2nd trimester/violent	--	--	--	--	11.5	(-326.7, 349.7)
1st trimester/violent	--	--	--	--	270.3	(-78.0, 618.7)
1-6 months prior/violent	--	--	--	--	370.3	(42.1, 698.5)

Table 3: Examination of birthweight and 95% confidence intervals in grams by interaction between exposure and ethnicity and exposure and violent region status, Demographic Health Survey, Kenya, 2008/2009

	Kikuyu	Non Kikuyu
3rd Trimester		
Violent Region	-333.5[a] (-510.1, -156.9)	-366.4[a] (-545.4, -187.4)
Nonviolent Reg	-138.9 (-319.1, 41.2)	-171.9 (-338.1, -5.7)
2nd Trimester		
Violent Region	-564.4[a] (-843.6, -285.1)	-261.8 (-614.6, 91.0)
Nonviolent Reg	-319.5[a] (-517.6, -121.5)	-17.0 (-159.9, 125.9)
1st Trimester		
Violent Region	-206.5 (-561.2, 148.2)	-123.9 (-458.0, 210.1)
Nonviolent Reg	-220.5 (-563.2, 122.3)	-137.9 (-311.8, 36.0)
1-6 Mo. Prior		
Violent Region	-262.1 (-570.9, 46.7)	-85.3 (-386.0, 215.3)
Nonviolent Reg	-376.1[a] (-624.6, -127.6)	-199.3[a] (-341.9, -56.7)

[a] $p<0.05$ based on Hochberg step up step down adjustment

Figure 2: Birthweight estimates and 95% confidence intervals in grams by exposure period and region among exposed Kikuyu compared to unexposed Kikuyu, Demographic Health Survey, Kenya, 2008/2009