Journal of Developmental Origins of Health and Disease (2014), **5**(5), 370–373.

doi:10.1017/S2040174414000348

ORIGINAL ARTICLE

Civil unrest linked to intrauterine growth restriction in western Kenya

E. Dybjer*, J. Linvik and P. M. Nilsson

Research Department of Clinical Sciences, Faculty of Medicine, Lund University, Malmo, Sweden

Risk factors associated with intrauterine growth restriction (IUGR) have previously been identified, but few studies have described the relationship between IUGR and maternal stress caused by exposure to civil unrest. Here, we investigate this relationship during the Mount Elgon crisis in western Kenya between 2006 and 2008, following a period of violence. Birth weight data were compared between three hospitals in an exposed area, Mount Elgon ($n = 570$), and one hospital in a control area, Kimilili ($n = 530$). In a sub-analysis, the most stress exposed hospital, Bungoma West ($n = 211$), was compared with the control hospital in Kimilili. Adjustments were made for offspring sex, gestational age and parity. The difference in mean birth weight between the most stress-exposed hospital (Bungoma West) and the control hospital (Kimilili) was 91 g after full adjustment ($P = 0.041$). In conclusion, epidemiological data suggest a significant relationship between exposure to civil unrest and IUGR causing lower birth weight.

Received 30 January 2014; Revised 10 May 2014; Accepted 26 June 2014; First published online 4 August 2014

Key words: birth weight, fetal programming, intrauterine growth, Kenya, stress exposure

Introduction

After a period of increasing instability in the Mount Elgon region in western Kenya, there was a period of crisis and civil unrest that lasted between 2006 and 2008. Civilians were trapped between the violence of a local guerrilla militia called the Sabaot Land Defence Force, and a Kenyan police operation in response to local violence and lawlessness. Around 60,000 people fled their homes. Many were physically and psychologically traumatized and many suffered from malnutrition.[1,2] Our hypothesis was that, since civilians were exposed to severe stress, it is likely that the conflict had an impact on intrauterine growth restriction (IUGR) and birth weight outcome.

A variety of environmental factors during pregnancy may influence birth weight outcome and the future health of the child, including nutrition, chemicals, drugs, infections and other stressors such as psychosocial factors. Recent studies have confirmed the hypothesis that maternal stress exposure during pregnancy is associated with an increased risk of low birth weight.[3–8] See also Bell *et al.*[9] for further references.

It has also been shown that an adverse intrauterine environment caused by stress exposure can have severe health consequences for offspring later on in life. Altered environmental factors may induce a stress response in the fetus that is characterized by reprogramming of the HPA axis[10], leading to a long-term activation of the sympathetic nervous system, and consequently an increased risk of cardiovascular disease later in life.[11]

*Address for correspondence: E. Dybjer, Department of Clinical Sciences, Lund University, Skane University Hospital, IM Nilssons gata 32, S-205 02 Malmo, Sweden.
(Email elin.d86@gmail.com)

The relationship between IUGR and civil unrest was studied after a period of violence in Kenya following the presidential elections of 2007. During the years 2007–2008, Kikuyu mothers affected by the crisis gave birth to babies that weighed 560 g less on average than a control group.[9] Apart from this study, there have been few studies on IUGR and stress during pregnancy in developing countries.

Taking the previous study in Kenya as our point of departure, this study aims to further strengthen the hypothesis that stress exposure during pregnancy caused by marked civil unrest is associated with IUGR. This is done by comparing mean birth weight outcomes in two districts in western Kenya, one with and one without a recent history of civil unrest.

Method

A comparison of birth weight data based on local medical records was made between two areas, one with a recent history of civil unrest and one without. The selected areas were the Mount Elgon region, which was highly affected by the crisis of 2006–2008, and the Kimilili region, a nearby area that was not immediately affected by the crisis. The data from the Mount Elgon region were obtained on site from three hospitals: Bungoma West Hospital, Mount Elgon District Hospital and Cheptais Hospital ($n = 570$). The data from the Kimilili region were obtained on site from Kimilili District Hospital ($n = 530$).

The Mount Elgon crisis had its peak during March 2008, when Kenyan authorities carried out a military operation to defeat the violent Sabaot Land Defence Force. The violence escalated and was intensive throughout the year 2008.[2] Birth

Table 1. *Descriptive data of the study sample from four hospitals in western Kenya with means, S.D. and gender distribution (%)*

Hospital	Kimilili (control)	Bungoma West (exposed)	Mount Elgon District Hospital	Cheptais	All Mount Elgon hospitals[a]	Total
n	530	211	174	185	570	1100
Sex, male/female (%)	283/247 (53.4/46.6)	104/107 (49.3/50.7)	94/80 (54.0/46.0)	100/85 (54.1/45.9)	298/272 (52.3/47.7)	581/519 (52.8/47.2)
Birth weight (kg)	3.12 (0.59)	3.01 (0.64)	3.09 (0.50)	3.27 (0.59)	3.12 (0.60)	3.12 (0.60)
Gestational age (weeks)	38.2 (3.0)	38.1 (3.8)	39.2 (1.7)	37.8 (2.5)	38.3 (2.9)	38.3 (3.0)
Parity (*n*)	2.7 (1.9)	2.6 (2.1)	2.7 (2.0)	2.7 (1.9)	2.7 (2.0)	2.7 (2.0)

[a]The Mount Elgon region included three hospitals: Bungoma West (with most stress exposed pregnant women), Mount Elgon District Hospital and Cheptais.

weight data from both areas were obtained from 8 months during the period of January 2008–June 2009, a period that overlapped and succeeded the peak of the crisis. We were not able to access data from the same months for all hospitals owing to missing pages in some of the handwritten medical record books, but all births during this period were significantly close to the peak of the crisis and to the violence that escalated and was present throughout 2008. The variables that were recorded for each subject were hospital, birth weight, sex, gestational age and parity. Twins and subjects with missing information for any of the variables were excluded.

The hospitals were selected according to formal access and local recommendations. Mount Elgon District Hospital, Bungoma West Hospital and Cheptais Hospital were selected because of their location in the affected Mount Elgon region, and Kimilili Hospital because of its location in a nearby area not immediately affected by the crisis. Cheptais was the area of the Mount Elgon region that was the most affected by the crisis. However, according to hospital staff, many women from Cheptais either fled to other villages or chose to give birth at home during this period, and therefore birth weight statistics may not be representative of the pregnant women most affected by the crisis. Large amounts of people fled from other parts of Mount Elgon to Bungoma West. It is therefore likely that women giving birth at Bungoma West Hospital would have been exposed to the most stress, that is displaced from their homes because of the crisis. For this reason, two analyses in which mean birth weight was calculated were carried out – one comparing data from Bungoma West Hospital (most exposed) to data from the Kimilili Hospital (control), and one comparing data from all three Mount Elgon Hospitals (exposed) to data from the Kimilili Hospital.

Statistical methods

Characteristics of the study sample (four hospitals) are shown in Table 1. Mean birth weight, gestational age and parity were calculated for each hospital separately, for the three Mount Elgon hospitals together (Bungoma West, Mount Elgon District and Cheptais), and for all hospitals in total. Proportions of offspring sexes (male and female) were also calculated for each hospital or group of hospitals. Differences in mean birth weight between hospitals without adjustment could then be compared.

To eliminate the impact of differences in the variables offspring sex, gestational age and parity on the differences in mean birth weight between groups, a multiple regression analysis was then carried out with birth weight as dependent variable and hospital, offspring sex, gestational age and parity as independent variables. In Table 2, the *B* unstandardized coefficient for the variable 'hospital' is equivalent to the difference in mean birth weight between Kimilili and Bungoma West Hospital, when adjusting for the variables offspring sex, gestational age and parity.

Results

The difference in mean birth weight between the most stress exposed hospital, Bungoma West, and the control hospital, Kimilili, was 110 g (95% confidence interval: 12–208 g; $P < 0.05$) but non-significant when comparing the whole Mount Elgon district (three hospitals) with the control hospital.

After adjusting for gestational age, offspring sex and parity using multiple regression analysis, the difference in mean birth weight between Bungoma West and Kimilili Hospitals remained significant (91 g, $P = 0.041$; Table 2).

Discussion

A significant difference in mean birth weight between the most affected region, Bungoma West, and the control region, Kimilili, was found, even after adjusting for the variables sex, gestational age and parity. This shows that the regional difference in mean birth weight cannot be fully explained by such variables, and that other detrimental factors must be present. It is likely that the difference in mean birth weight was caused by intrauterine stress and IUGR in the affected region, where many pregnant women suffered from psychosocial stress and lack of nutrients.

No significant difference in mean birth weight was found between the three Mount Elgon hospitals taken together on the

https://doi.org/10.1017/S2040174414000348 Published online by Cambridge University Press

Table 2. *Multiple regression analysis with birth weight as dependent variable and hospital, offspring sex, gestational age and parity as independent variables, including data only from the Kimilili and Bungoma West Hospitals, Kenya*

	Unstandardized coefficients		Standardized coefficients		
Variable	*B*	S.E.	β coefficient	*t*	*P*-value
Constant	− 0.21	0.239		− 0.88	0.38
Hospital	0.091	0.044	0.067	2.05	0.041
Sex	0.089	0.040	0.072	2.20	0.028
Gestational age	0.081	0.006	0.427	13.1	<0.001
Parity	0.040	0.010	0.130	3.96	<0.001

one hand and Kimilili Hospital on the other. The reason for this could, as mentioned earlier, be that the data from two of the hospitals was not necessarily representative of those most affected by the crisis as many pregnant women fled from exposed areas, leading to selection bias.

The results of this study are in line with the results of the previously mentioned study in Kenya following the political elections of 2007, in which the most stress-exposed group of Kikuyu mothers had babies that weighed on average 560 g less than those of a control group.[9] The two studies differ somewhat in material and methods owing to access to different types of data. In the previous study, data obtained from the Kenyan Demographic and Health Survey (KDHS) conducted in 2008–2009, allowed the researchers to take more different variables into account, for instance maternal age, education, wealth index and ethnic group (Kikuyu/non-Kikuyu). This allowed the researchers to describe more different levels of stress exposure in the data, and to identify the group of most affected Kikuyu mothers. This could be one of the reasons that the difference was greater between the most affected group and the control group than seen in our study. The data of the previous study in Kenya included all children born during the period of interest, both those with and without a recorded birth weight. In this study, data were obtained from local hospital registers. We could therefore not access information about mothers giving birth outside hospitals. However, we had additional information about gestational age, an important variable to adjust for when assessing the level of IUGR.

An important limitation to the study was the low percentage of hospital deliveries of the total number of births – the nationwide average rate of births in health facilities was 43% based on the KDHS 2008–2009. According to this survey, living in rural areas, being less wealthy and being less educated were factors associated with less likelihood of delivering in hospital facilities. The effect of distance from a health facility was not significant after controlling for other variables.[12] Regarding this information, it is likely that <43% of mothers in the Kimilili and Mount Elgon areas delivered in hospital facilities, since both areas are located in rural western Kenya. Another limitation to the study was the uncertainty about the impact of crisis-related factors in different parts of the Mount Elgon region. Around 60,000 people were forced to leave their homes,[1] and there is very little information registered about the details of the re-location of the affected individuals during the period of crisis. However, according to locals on site, many people fled to Bungoma West from more violent areas of the Mount Elgon region. A possible confounder is, however, that a number of people also fled from Mount Elgon to Kimilili (the control area) during this period. Apart from the crisis in Mount Elgon, it is possible that other factors such as individual variations in socio-economic status, ethnicity, body mass index (BMI) and also regional differences in prevalence of infections, agricultural structure and crops, had an impact on the difference in mean birth weight between the areas. As there was no such information available in the local medical records, we interviewed locals on site about regional differences between the populations. However, according to these locals, there are neither great socio-economic nor ethnic variations between the areas, nor are there great differences in BMI. The lack of crops and agriculture was, however, greater in the Mount Elgon area during the crisis, which lead to great malnutrition and starvation among the population.[2] According to locals, due to lack of shelter, many families in Mount Elgon were forced to sleep in the bushes, and were therefore exposed to infections such as malaria. Recent studies have also showed that there is a significant genetic component affecting birth size.[13] It is therefore important to take into account that genetic variations between the groups may have further influenced differences in birth weight. In summary, it is likely that, apart from genetic variations between the groups, differences in birth weight were because of a combination of different crisis-related factors, that is, nutritional, health-related and psychosocial factors.

There are, as previously mentioned, few studies that describe the association between IUGR and civil unrest in developing countries. Therefore, similar studies in other locations and ethnic groups would be of interest to support the hypothesis that this relationship is significant. It would also be of value to study all districts in the Mount Elgon region that were affected by the crisis including the so-called 'safe havens' that people fled to, and to find a way of assessing the degree of stress exposure on an individual level, for example by use of a stress risk score.

In conclusion, this record-based study with local data from exposed areas suggests a relationship between IUGR and stress exposure, associated with malnutrition, linked to civil unrest in a rural African setting.

Acknowledgments

We would like to express our gratitude to Gerry Nyongesa, David Psirmoi, Dr Achiyenza Shikunzi, Margareth Atieno, Gull Nyongesa, Robert Sifuna, Jacinta Makogilo, Alex Wandati,

Dauglas Shivina Shihunwa, Shiko Lucy Shihunwa and Dr David Wanikina who provided us with the local support we needed to carry out the study.

Financial Support

This study was supported financially by the Faculty of Medicine at Lund University, Sweden, and by the strategic research network EpiHealth at Lund University.

Conflicts of Interest

None.

Ethical Standards

The authors assert that all procedures contributing to this work comply with the ethical standards of relevant national guidelines and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by the institutional committees (Faculty of Medicine, Lund University).

References

1. Médecins Sans Frontières Australia.The hidden crisis of Mount Elgon in Kenya: 'We eat from the hands of others…'. 7 September 2007. Retrieved 31 January 2013 from http://www.msf.org.au/from-the-field/field-news/field-news/article/the-hidden-crisis-of-mount-elgon-in-kenya-we-eat-from-the-hands-of-others.html
2. Médécins sans frontières. Report: Mount Elgon: does anybody care? 16 June 2008. Retrieved 20 July 2014 from http://www.lekari-bez-hranic.cz/cz/downloads/MSF_MtElgon_May2008.pdf
3. Eskenazi B, Marks AR, Catalano R, Bruckner T, Toniolo PG. Low birth weight in New York City and upstate New York following the events of September 11th. *Hum Reprod*. 2007; 22, 3013–3020.
4. Witt WP, Cheng ER, Wisk LE, *et al*. Maternal stressful life events prior to conception and the impact on infant birth weight in the United States. *Am J Public Health*. 2014; 104(Suppl. 1), S81–S89.
5. Nkansah-Amankra S, Luchok KJ, Hussey JR, Watkins K, Liu X. Effects of maternal stress on low birth weight and preterm birth outcomes across neighborhoods of South Carolina, 2000-2003. *Matern Child Health J*. 2010; 14, 215–226.
6. Zhu P, Tao F, Hao J, *et al*. Prenatal life events stress: implications for preterm birth and infant birthweight. *Am J Obstet Gynecol*. 2010; 203, e1–e8.
7. Khashan AS, McNamee R, Abel KM, *et al*. Reduced infant birthweight consequent upon maternal exposure to severe life events. *Psychosom Med*. 2008; 70, 688–694.
8. Nasreen HE, Kabir ZN, Forsell Y, Forsell Y, Edhborg M. Low birth weight in offspring of women with depressive and anxiety symptoms during pregnancy: results from a population based study in Bangladesh. *BMC Public Health*. 2010; 10, 515.
9. Bell S, Prata N, Lahiff M, Eskenazi B. Civil unrest and birthweight: an exploratory analysis of the 2007/2008 Kenyan crisis. *Soc Sci Med*. 2012; 74, 1324–1330.
10. Phillips DI. Programming of the stress response: a fundamental mechanism underlying the long-term effects of the fetal environment? *J Intern Med*. 2007; 261, 453–460.
11. Johansson S, Norman M, Legnevall L, *et al*. Increased catecholamines and heart rate in children with low birth weight: perinatal contributions to sympathoadrenal overactivity. *J Intern Med*. 2007; 5, 480–487.
12. Kitui J, Lewis S, Davey G. Factors influencing place of delivery for women in an analysis of the Kenya demographic and health survey, 2008–2009. *BMV Pregnancy Childbirth*. 2013; 13, 40.
13. Lumey LH, Susser E, Andrews H, Gillman MW. Birth size and adult size in same-sex siblings discordant for fetal growth in the Early Determinants of Adult Health study. *J Devel Orig Health Dis*. 2011; 2, 330–339.