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THE IMPACTS OF CLIMATE CHANGE AND WEATHER VARIATIONS ON THE SEX RATIO AT BIRTH AND CHILD HEALTH IN BRAZIL

Bernardo Lanza Queiroz
Department of Demography – Universidade Federal de Minas Gerais
(lanza@cedeplar.ufmg.br)

Alisson Flávio Barbieri
Department of Demography – Universidade Federal de Minas Gerais
(barbieri@cedeplar.ufmg.br)

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1 – INTRODUCTION

The sex ratio at birth, the ratio between the number of males per females in a population , is generally around 105 and believed to move slowly across time. Astolfi & Zonta (1999) show that sex ratio at birth increase until mid-XXth century and started a downward trend since 1950 for several countries, for example Latin America since 1970 (Feitosa & Krieger, 1992). The upward trend is generally associated with improvements in pre and neo-natal care which increased the probabilty of survival of male babies who are more fragile and have higher probability of death in poor conditions (Astolfi & Zonta, 1999). The debate on the determinants of downward trend is still open. There are some evidence on the impacts of environmental hazards (James, 1997) and that it was signaling a deterioration of general health in a population (Davis, *et. al*., 1998).

A sociobiological literature, however, suggests that the mother's circumstances may affect sex outcomes. The sex ratio at birth decreases in populations affected by exogenous shocks. The literature shows evidence of changes in sex ratios for populations affected by earthquakes (Fukuda *et. al*, 1998), environmental pollution (Mocarelli *et. al*. , 1996), political crisis (Catalano, 2003) and high unemployment (Catalano and Bruckner, 2005). There are two groups of explanations for the evidence. The first one argues that stress during the pregnancy induces hormones that increase the chances of spontaneous abortions, which tend to affect more male than female fetuses. This mechanism is argued to protect the population, since it increases the chances that the population will not cease to exist. The second group is related to the fathers. The literature shows that stress reduces sperm mobility thus reducing the chances of male fetuses. In addition to that, stressful situation reduces the frequency of coitus what affects the chances of male conception.

The literature on social and economic impacts of climate change discusses the impacts on the transmission of several diseases, economic impacts and general health impacts. In this paper we concentrate on the possible impacts that could affect children's health. Weight at birth is considered the most appropriate measure of health condition in early life and it is considered an important predictor of different situations over the life-cycle (Almond and Currie, 2011; Currie, 2011). Early life conditions, especially health, have important effects on their health in the future, school performance and productivity in the labor market (Heckman, 2007; Almond, Chay and Lee, 2005). There are a large number of studies showing how health and education of

mothers, the local economic situation and environmental variables can affect the birth weight of children (Kramer, 1987).

The empirical research on the impacts of climate variation to child's health is incipient and limited, probably due to data limitations. For example, Deschenes et al (2009) investigate the impact of extreme high and low temperature on birth weight in the USA. They find that regions with prevalence of very high temperature have a higher prevalence of low birth weights. Grace and Brown (2012) studied the relation of rainfall fluctuation on food availability and their impact on health conditions in Kenya. In the case of Brazil, Rocha and Soares (2011), studying the impact of variations in rain season, find that areas affected by longer dry seasons experience worse indicators of health conditions (lower birth weight, more preterm births and higher infant mortality). Junger and Leon (2007) estimated the impact of air pollution on low birth weight in the city of Rio de Janeiro. They found that mothers who were more exposed to air pollution have a higher chance of giving birth to low weight children, a result similar to what was found for Sao Paulo.

In this paper, we expand this analysis by investigating the seasonality of sex ratio at birth and birth weight across municipalities in Minas Gerais, Brazil. Minas Gerais is an interesting case to study. The state of Minas Gerais is one of the most heterogeneous country (see Map 1). Dynamic regions coexist in the state, and with modern socio-economic indicators and high level locations also delayed, offering a stagnant condition of life more precarious for its population. On the one hand there is the South-Central region and the Mining Triangle, the most developed area of greater economic dynamism and the largest share of domestic product. And the other Eastern and Northern Zones, characterized by economic dynamism and expressiveness weaker and worse social indicators. (Queiroz et al, 2010).

Also, and more important, in the state we can find large variation in climate conditions and over the year (Map 2). The temperature in the Northeast and Vale do Jequitinhonha is marked my long periods of drought whereas the temperature in the south and west of the state is more stable and with more regular rainy seasons. We also argue that variation in weather has direct impacts in the economy, affecting household income level and social conditions, what could have an impact on child's health (Barbieri, et al, 2010). The study for Minas Gerais is also important because we have a long series of birth data (including sex, weight at birth, APGAR score, and some characteristics of the mother) as well as climate data for each city in the state

from 1960 to 2010, including average monthly temperature and rain.

2 – MATERIALS AND METHODS

2.1. - Data

The data from this paper come from three different sources: live births administrative records, information about socioeconomic conditions by municipality, and weather/climate information. The main source of information is the Information System on Live Births (SINASC). Sinasc collects information on births, with its most important features, such as sex, where the birth occurred, type of delivery and birth weight, APGAR indices, exact date of birth as well as a series of information about the mothers. Data are available since 1994 at the municipal level. For example, 2010 data contains about 255000 births across 853 municipalities. The information allows us to construct a dataset of births by municipality by month from 1994 to 2010.

It is possible to construct socioeconomic indicators from SINASC data, but information on mother's occupation and educational attainment, and even age, is considered to be of poor quality for most of the period (Rocha and Soares, 2011; Andrade et.al, 2004). We opted to constructed municipality level indicators as a measure of socioeconomic conditions. We obtained socioeconomic indicators from different sources: economic growth and income per capita comes from Ipeadata datase (www.ipeadata.gov.br), availability of health services comes from the Ministry of Health, information on educational attainment comes from Census data.

The third source of information is being constructed under the project "*Vulnerabilidades e Adaptação às Mudanças Climáticas: uma avaliação integrada das dimensões sociodemográfica, econômica e de saúde para o estado de Minas Gerais*". The project is organization a long-series database on the climate conditions in Minas Gerais and a forecasting model. The data includes information of average weather and average rainfall by month for each of the 853 cities in the state of Minas Gerais.

2.2. - Methods

The analysis is presented in three parts. The first part presents a series a descriptive statistics showing the variation of the sex ratio at birth and weight at birth across municipalities

in Minas Gerais between 1994 and 2010 and how it relates to variations out of the average overtime. In other to obtain the possible impacts of weather changes, we will follow the procedure proposed by Maccini and Yang (2009). This method has already been applied by others, for example Bonjean; Brunelin and Simonet (2012) for Burkina Faso. In summary, monthly climate shocks are estimates as the climate (weather and rainfall) variation from the calculated average for each municipality in that particular month.

The second part analysis the variation in the weight at birth by month of birth in Minas Gerais. We measure health condition by using weight at birth for each child. We also test the model using weight at birth z-score. The z-score is calculated by the difference between the birth weight observed for each child and the median weight at birth for a reference population. The model is estimated for all 853 cities in Minas Gerais using data from 1980 to 2010. We also examine the variation in the sex ratio at birth by city and month of birth. We estimate the models using fixed-effect models and controlling for a series of regional characteristics (education, gdp per capita, % poor, general living conditions).

3 – EXPECTED RESULTS

The results of our analysis will highlight the relationship between birth health, sex ratio at birth and environmental factors reflecting changing climate patterns. We assume that climate variations will have impacts on the economic and social conditions in the state of Minas Gerais, and that these impacts will vary across the different regions of the state (Barbieri, et. al, 2010). We anticipate that even after controlling for regional and socioeconomic variables, biological variables, children born to women who were pregnant during the period of severe weather shocks will have higher chance of dying before turning 1, will be born with low birth weight. Our research will assist in developing strategies to overcome vulnerability and improve the adaptive capacity of the most at risk groups of the Brazilian population.

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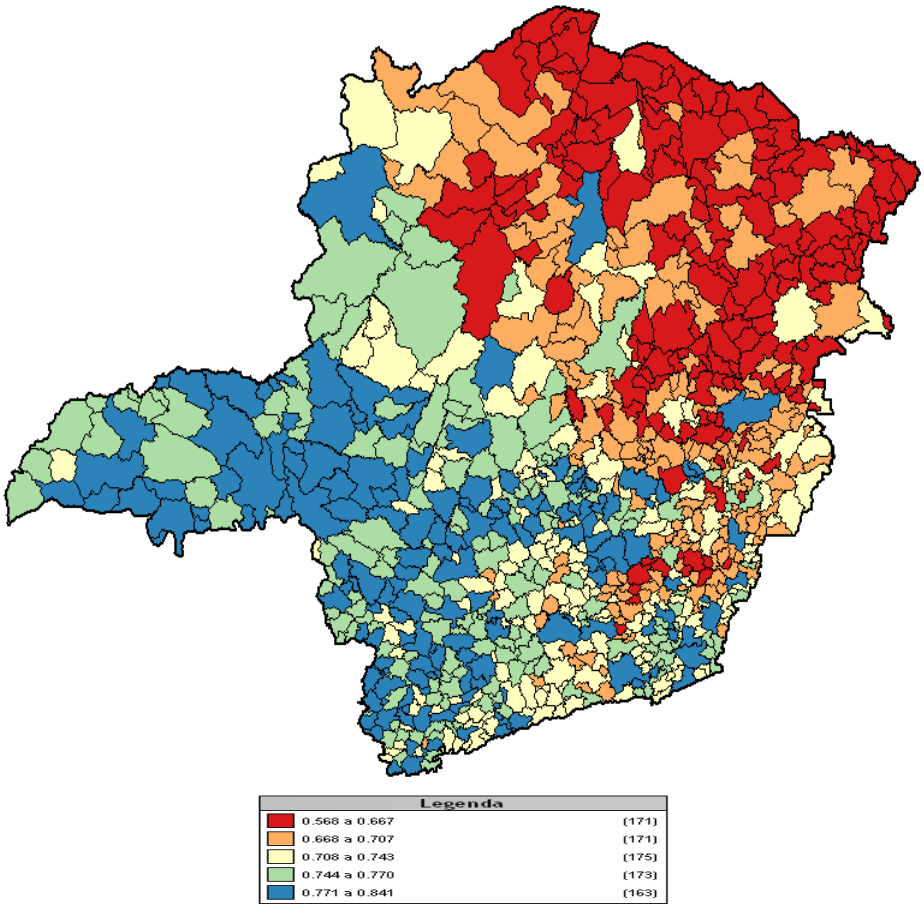
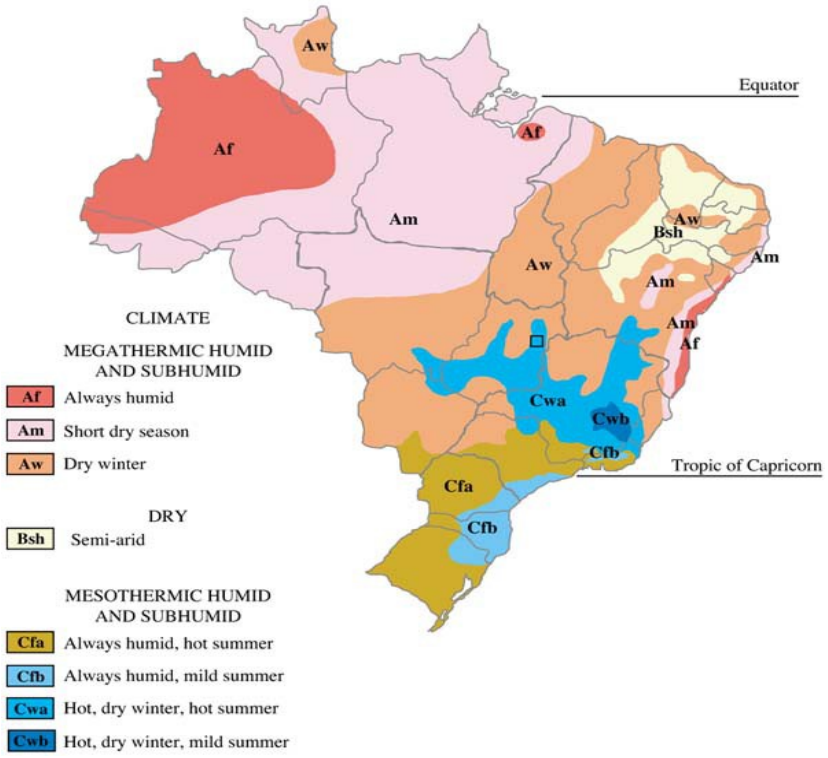
Map 1 – Human Developing Index, Minas Gerais, 2000 (municipalities)



Map 2 – Basic Characteristics of Weather Conditions in Brazil and Minas Gerais



Source: http://www.fao.org/docrep/007/y5376e/y5376e06.htm (GuiaNet)