

Research Article

Is there a Link between Preterm Birth and *In Utero* Exposure to Climate Change?

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Abstract

Aim: The aim of this study is to clarify if there is a link between preterm birth and temperature as a climate factor. Our study comes after a long period of clinical experience that rose the suspicion of a possible correlation between temperature variation and peaks of premature births.

Materials and method: We conducted a retrospective study on the number of births registered at the "Dr. I.A. Sbarcea" Clinical Hospital of Obstetrics and Gynecology in Brasov in 2018 and 2019. Data related to premature birth was further correlated to climate information regarding Brasov area obtained from the National Administration of Meteorology, Romania and to results of fertility statistics made publicly available by the Romanian National Institute of Statistics.

Results: Our study group included 99 premature births registered at "Dr. I.A. Sbarcea" Clinical Hospital of Obstetrics and Gynecology in Brasov in 2018 and 127 in 2019. The premature birth rate peaks in August for both years of study: 2018 and 2019. Statistical data processing shows there is significant correlation between *in utero* exposure to extreme temperatures and registration of peaks of premature births.

Conclusion: Recognizing a pattern of the raise in the premature birth rate may help the healthcare system to cope with the increased demands of the pediatric care units in time periods marked by specific climate context. Easy recognition of climate conditions that can consequently lead to a peak in the rate of premature birth can be useful for medical staff and patients.

Keywords: Premature birth; Temperature; Climate change

Introduction

Prematurity represents a medical entity that impacts the life of both baby and family through its numerous connection determined by economic and social characteristics. Unfortunately even in our times prematurity determines most deaths in children having less than 5 years of age [1].

We furtherone refer to premature babies as to those babies that are born before 37 full weeks of gestation [2,3].

The problem risen by prematurity affects medical systems worldwide as it consolidates as a major global health problem. Children born prematurely often develop a series of affections on a long run becoming prone to illnesses more than individuals born at term [4].

Prematurity treated as a complex pathology affecting multiple organism represents thus an important hallmark in the life of a human being. The impact early development has on later life disease is highlighted when mentioning premature infants fact also sustained by the thrifty phenotype hypothesis according to Wells et al. (2002) [5].

Although multiple factors can lead to a premature birth the pathophysiological pathways that certainly cause this pathology are not fully understood yet [2].

A series factors such as low income, low education level, little or no access to healthcare services maternal age are considered to increase the chances to deliver prematurely. As individuals are born very prematurely, respectively at less than 32 weeks of gestation their morbidity on a long term is affected according to D'Onofrio et al. and Jarjour IT [6,7].

Furthermore prematurity represents a cause for further learning and motor disabilities and also for hearing and visual impairment [8]. The special needs of the extremely premature infants in the intensive care units require not only highly trained medical staff but also very expensive management costs despite maintaining a reserved general outcome. Fortunately, the outcome of extremely premature infants tends to get better as advances in neonatology are made [9].

Exposure to hot temperatures *in utero* associates to higher risk of preterm birth according to both Carolan-Olah M. et al. and Zhang Y. et al. [10,11] Scientific literature tends to offer a reduced homogeneity regarding results of studies on premature birth and exposure to heat as most probably a series of factors such as climate and geographical specifications and socioeconomic conditions alter markedly their findings.

Most probably this reduced homogeneity is due to the fact that along to climate factors there are also geographical specifications that may alter algorithms through which extreme temperature may affect premature birth.

Differences on whether warm or rather cold extreme temperatures impact premature births peaks appear to affect differently pregnant women in different geographical area. Because in pregnant women the ability to maintain a balanced body temperature is modified their capacity to cope with extreme temperatures may increase the risk of premature birth [12].

Peaks of premature birth rate were reported during winter in countries such as England and Sweden and in spring and summer in Greece [12-14].

According to Bruckner T.A et al and Sus S et al. *in utero* exposure to low temperatures correlated not only to preterm birth but also to stillbirths [15,16].

The study of Zhong et al. shows correlation between *in utero* exposure to increased ambient temperature and high risk of preterm delivery, especially during night thus highlighting both a climate and a diurnal- nocturnal variation of this pathology [17].

The objective of our study is to analyze on a monthly basis the statistical correlation between the rate of premature births registered at the “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology in Brasov and the minimum, mean and maximum monthly temperature registered in Brasov county in 2018 and 2019.

Material and Method

Study population

We conducted a retrospective study on the number of premature births registered at the “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology in Brasov between the first of January 2018 and the 31st of December 2018.

We included in our study the premature births uncomplicated by the presence of other pathological entities such as pregnancy hypertension, intrauterine growth restriction, obvious fetal malformation. We included in our study all births registered in 2018 and 2019 without applying any exclusion criteria related to race, religion or citizenship.

Environmental data

In the context of global warming *in utero* exposure to extreme temperatures requires attention as it may impact the health status of both mother and fetus. However, the pathophysiologic mechanism through which extreme temperature may determine premature birth remains unclear [18].

Both high and low temperatures during pregnancy may be incriminated in increasing the risk of premature birth [19].

Our data regarding premature births was further statistically correlated to exposure to environmental temperatures. Meteorological data was obtained through a contract with the National Administration of Meteorology, Romania.

Brasov is located in a continental climate area, presenting with relative humid characteristics and lower temperatures especially in lower areas. At a thorough monthly temperature analysis between 2015 and 2019 we notice that the lowest temperature was reached in 8 January 2015, registering -33.3°C. In contrast, in the same time interval (2015-2019) we notice that the hottest day was 5th of August

2017 when we registered 36.9°C.

The temperatures used in our study are represented by actual temperatures registered at the Brasov weather station purchased via individual contract from the National Meteorological Administration, Climatology department. The temperatures used in statistical analysis are represented by monthly minimum, maximum and average for 2018 and 2019 at Brasov weather station.

Statistical data concerning fertility rate and geographical distribution of the number of births were obtained using publicly available statistical data made available by the Romanian National Institute of Statistics [20]. We have accessed information related to Brasov county for 2018 and 2019 regarding natality.

Statistical analysis comprising of regressions were performed regarding minimum monthly temperature, maximum monthly temperature and monthly rate of premature births registered at “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology in Brasov.

Results and Discussion

We analyzed a total number of 4242 birth registered in 2018 at the “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology of Brasov. For the year of 2019 we analyzed a total number of 4359 births.

In 2018 interval there were 2263 singleton births, 26 cases of birth using obstetrical vacuum extractor and 1888 births through cesarean section. We registered zero cases of maternal death and zero uses of forceps use for the selected time period.

In 2019 we notice there were 2326 singleton births and 1969 births through cesarean section. We report zero cases of maternal death and zero cases of forceps use.

In 2018 we noticed that most of the births registered come from urban areas, only 39.81% originating in rural areas. Furthermore, in less than 1% of the births (0.89%) the age of the mother was equal or less to 14 years of age. At the opposite end we notice a total number of 7 births registered in the 45-54 years of age group. Most of the births registered in our hospital results from mothers having between 25 and 34 years of age (2223).

The total of 4242 births registered in 2018 sum up for 25386 days of hospitalization with an average of 5.9 days per case. Out of the 4242 births, 99 were premature births registered as having less than 37 weeks of pregnancy.

In 2019 at our hospital there were a total of 4359 births, out of which we identified a total of 127 premature births having less than 38 weeks of pregnancy.

Out of the 4359 births registered in 2019 we notice that 40.90% of women declare residency in the rural area. Moreover 2272 of them are aged between 25-34 years and only 5 births were registered in women having more than 45 years of age. From the total number of births registered in 2019 we notice a number of 1969 cases of cesarean section with zero cases of maternal death or forceps usage.

We mention that births included in our study were selected using the medical coding system currently used in “Dr. I.A. Sbarcea” Clinical

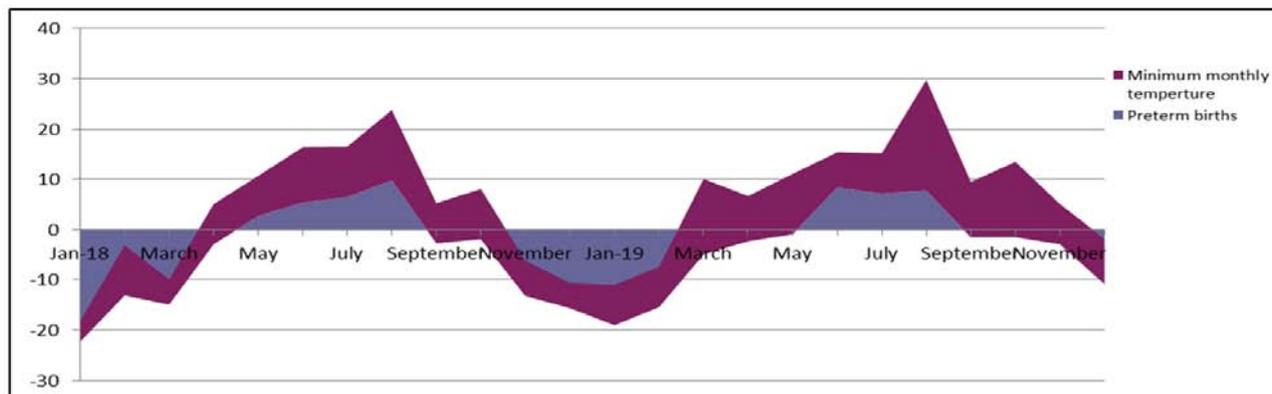


Figure 1: Influence of minimum monthly temperatures on the preterm birth rate: the figure shows the correlation between the minimum monthly temperatures registered in 2018 and 2019 and the monthly registered number of premature births.

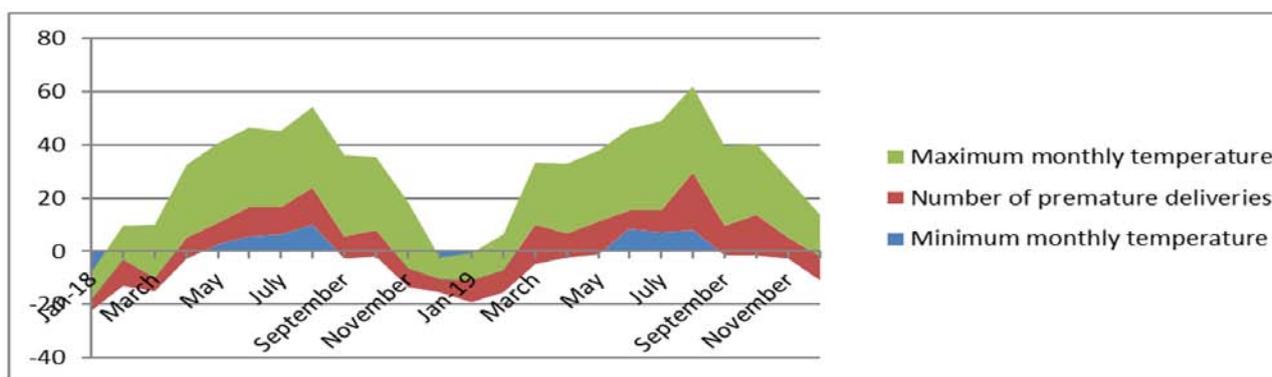


Figure 2: Influence of minimum and maximum monthly temperatures on the preterm birth rate: the figure shows correlation for both the minimum and maximum monthly temperatures registered in 2018 and 2019 to the monthly number of premature births.

Hospital of Obstetrics and Gynecology of Brasov”. By selecting codes referring to premature births and excluding pathologies such as gestational hypertension, eclampsia, preeclampsia, detachment of normally inserted placenta, gestational diabetes, and obvious fetal malformation we identified our study groups for both 2018 and 2019.

The results for the monthly premature rate for 2018 is consistent with the findings of the scientific literature as we notice the maximum number of preterm births registered in the months of June, July and August. In 2019 we notice that the months with the highest peaks of premature birth rates were August, October and March. We thus notice there is a trend for peaks of premature births in the summer in the area of Brasov as maybe this corresponds to geographic and climate specifications.

By analyzing the climate characteristics between 2015-2019 recorded at Brasov weather station we notice that in 10 of the 60 studied months the average monthly temperatures are below the freezing point and in 39 out of the 60 months the minimum monthly temperature is below 0. Moreover, the fact that the monthly average temperature never exceeds 21°C in our studied time interval makes it clear that according to the geographical specifications of our region correlations to cold temperatures are more important than those with warm ones.

In 2018, according to climate reports registered at Brasov weather station, the lowest temperature was registered on the 25th of January and it measured -22.3°C. In the same year (2018) the hottest days were 15th of August and 2nd of September when we registered 30.6, respectively 30.9°C. Considering the average monthly temperature, August is by far the hottest month, having an average monthly temperature bigger with 1.8°C more than July and 2.1°C more than June.

The “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology of Brasov represents one of the most important obstetrical center for the central region of our country as it deals with 65.03% of the pregnancies registered in Brasov and its surroundings (both municipality and surrounding cities and villages).

In the central region of our country there were a total number of 206575 live births in 2018 and 203109 live births in 2019 [21].

When we report the number of live births registered in Brasov in 2018 and 2019 we observe that “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology deals with 65.03% of the live births registered in Brasov county in 2018 and with 68.24 % of the life births registered in Brasov county in 2019.

Our study revealed that in 2018 there is a strong statistical

correlation between the minimum monthly temperature and the number of premature births. We analyzed the statistical correlation between the monthly rate of the premature births to the minimum monthly temperature using regression statistics. We obtained a Multiple R equal to 0.86 and a p-value of .0005 which translates into a significant correlation making thus monthly premature birthrate highly correlated to the monthly minimum temperatures.

As our attention focuses on maximum monthly temperatures registered in 2018 we notice through regression statistics a Multiple R equal to 0.60 and a p-value of .03 meaning there is a statistical significant correlation between the two sets of variables.

In the light of this information it is more precocious to state that most probably the premature birth rate is sensitive to the thermal shock, but a bit more affected by the cold as the studied region is located in a geographical depression where there is a strong influence of the mountain climate.

Moreover we also notice the same trend of increased preterm deliveries as the minimum monthly temperatures lowers is noticed during 2019 Figure 1.

Furthermore if we overlap the influence of the maximum monthly temperature the char becomes more dramatic and easier to understand at a glance Figure 2.

Our study shows that temperature is correlated to registration of peaks of increased rate of preterm deliveries therefore could presents itself as a risk factor for this pathology.

Correlation between daily exposure to warm or cold temperatures shows a non-linear correlation as most often effects of exposure to extreme temperatures takes more than one day to show off. Our monthly analysis gives the organism sufficient time to develop enough effects due to exposure to extreme temperatures in order for pathologies to manifest. Studies that correlated exposure to climatic factors up to 1 week before the birth was registered failed to show a statistical correlation between preterm delivery and temperature [22].

Our results show consistency with the findings of Bruckner T.A. et al that reports that cold temperatures during pregnancy increase the risk for premature delivery [15].

Moreover, similar patterns in which we notice peaks of premature birth rates when *in utero* exposed to extreme temperatures are observes in the study of Shanshan Li et al. who also correlates them to stillbirth (2018) [19].

Similar to findings in the scientific literature, preterm delivery is also affected by warm extremes as we notice that August in our study is the month with the highest number of preterm deliveries in 2018. Our study shows similarity to the scientific literature as the rates of the premature birth show a statistical correlation to the minimum monthly temperature but also a peak of premature birth rate in the summer [15].

A study performed in London, a city that has the lowest part of the region in the central area in terms of altitude shows preterm delivery only peaks during winter with no other peak registered in another season [22]. The scientific literature also correlates the presence of fetal coarctation of the aorta to exposure to extreme cold

during embryogenesis making babies affected by this pathology proof of temperature-related morbidity [23].

According to geographical specifications of each region warm or cold extreme temperatures become stressful enough for the human body to determine a pathological process. An example is the study of Andreas D. Flouris conducted in Greece that shows marked risk for premature birth during summer as thermal comfort limit is much exceeded [14].

Interestingly a study performed in a great number of countries with different climates shows the impact that cold has on events triggering death concluding that the days of extreme temperatures are the ones substantially contributing to a so called temperature-related mortality [24]. If we consider that premature delivery dramatically influences the survival rate of the offspring it is easily to extrapolate the impact that *in utero* exposure to cold has.

Effects of temperature on an impressive study group comprising more than 1 million births registered in China concluded that exposure to extreme temperature may be identified as a risk factor for premature birth [18].

Another study realized on an impressively large study group comprising 32 million singleton births in USA correlated days with extreme heat with higher risk of premature birth [25].

Temperature augmentation in the context of global warming may be a risk factor for different pathologies affecting children ever since *in utero* existence. According to Chersich MF et al. in one of the most comprehensive meta-analysis regarding high temperatures and preterm birth this pathology appears to be more relevant when temperature raises rather than when it lowers correlating thus high temperatures to peaks of premature births more than lower ones [26].

As more and more studies show seasonality and weather sensitivity of the preterm delivery rate healthcare systems should consider specific climate features in order to assign more resources in the periods of high demand. Premature births tend to peak during the warm seasons, most common during summer especially when analyzing spontaneous preterm delivery [27].

Conclusion

Our study started from a clinical observation that connects climate factors to the prevalence of premature delivery.

After a thorough research of climate characteristics and births registered to the “Dr. I.A. Sbarcea” Clinical Hospital of Obstetrics and Gynecology of Brasov we conclude that there is a connection between *in utero* exposure to extreme temperatures and prevalence of preterm birth.

Our study shows a significant correlation between monthly exposure to extreme temperatures and adverse obstetric outcome as represented by premature delivery.

Most probably due to geographical characteristics, in Brasov county we notice peaks of premature deliveries correlated more to cold temperatures rather than to cold ones.

In utero exposure to extreme temperatures may be identified as a risk factor for premature birth. Our results earn value as it may

suggest when to assign more resources towards hospitals dealing to premature births in those periods identified as of high demand.

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