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EFFECT OF METEOROLOGICAL PARAMETERS ON ADVERSE PREGNANCY OUTCOMES IN THE NORTH-EASTERN REGION OF BANGLADESH

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ABSTRACT

Temperature has several health implications, especially for individuals with compromised immunity, such as pregnant women. The objective of this study was to examine the correlation between the highest temperature (Tmax) and the rate of premature births, as well as to understand the mechanism behind this relationship. Data were gathered from the Rangpur Medical College Hospital (RpMCH) for the period spanning from 2019 to 2021. A grand number of 14,354 birth data points were gathered. Out of the total deliveries, 48.77% were classified as normal, 32.12% were caesarean deliveries, and 18.56% were premature deliveries occurring before 36 weeks of gestation. We examined the occurrence of premature birth throughout the months of May to October, which experience the highest temperatures of the year and include the days with the highest maximum temperature (Tmax). We observed a positive link between the maximum temperature (Tmax) and premature delivery. However, this correlation was not statistically significant for the specified years. The corona shutdown resulted in a decrease in temperature over the examined years, which may have influenced the reduced rate of preterm deliveries during that time. Due to the constraints of data accessibility, doing this type of study is particularly challenging for nations such as Bangladesh. Preserving the delivery data and digitization are crucial. Conducting this type of study will be more manageable for researchers, and providing appropriate recommendations for precautionary measures will be more straightforward for clinicians.

Key words: Climate change, premature birth, pregnancy

Introduction

The health of pregnant women has not given that much attention and identified as the vulnerable group until recent years (UNFCC, 2017; USAID, 2019). The mass people seem to unaware about the threat of temperature and other weather parameters on pregnancy as well (de' Donato *et al*., 2015). The recent report of Euro-PERISTAT showed that the preterm and still birth of children still had a growing trend in Europe (European Health Perinatal Report 2014). Another study showed that the premature birth of infant can not only cause the lifelong disability but also the high mortality of the children (Martin *et al*., 2000; Osmondand Barker, 2000). Beside temperature several other factors can also act as a reason for the premature delivery. Several array of studies showed that air pollutant i.e. PM_{10}, $PM_{2.5}$ and NO_2 had a negative impact on the health of pregnant women and their unborn child (Pereira *et al*., 2014). Another study also showed that the noise exposure has a positive association with the pre term birth for the women who work at airports or a place where the noise level is higher (Figà-Talamanca, 2006). Pregnancy increases women's susceptibility to environmental risks, particularly external heat. The physiological and anatomical alterations that transpire during pregnancy present specific obstacles to thermoregulation (Laburn, 1996). Internal heat generation increases due to fetal and placental metabolism, as well as augmented body bulk and the consequent physical exertion (Wells, 2001). Similarly, pregnancy may highlight social vulnerabilities, particularly in poor and middle-income nations, where women frequently

persist in home duties during gestation, such as collecting wood and water, and engaging in subsistence agriculture. Exposure to elevated temperatures in agricultural and outdoor labor may transpire even to the acknowledgment of pregnancy (Judge *et al*., 2004; Suarez *et al*., 2004) and even late in gestation, economically disadvantaged women may exceed their thermal tolerance to prevent loss of income (Flocks *et al*., 2014). Systematically recording the correlation between heat exposure and maternal and newborn health is essential for estimating the total burden of climate-related illnesses, particularly as unfavourable birth outcomes, such as preterm, significantly contribute to the loss of person-years in these assessments (GBD, 2017). Assessing disease burden is essential for enhancing resource allocation to adaptation programs for pregnant women, monitoring progress over time, and bolstering arguments for climate change mitigation. This research has been conducted in light of the current context and previous developments. The aim of this research was to find the effects of heat exposure on preterm birth and examining the relation among high temperature and premature delivery.

Materials and Methods

Study area: The study was conducted in Rangpur Medical College Hospital (Fig. 1). Located in the northern Bangladeshi city of Rangpur, Rangpur Medical College (RpMC) is a distinguished government medical institution that was founded in 1970.

Fig.1. Map of Bangladesh showing the study areas (Source: Mapdata google)

Situated in the north-western part of Rangpur, it is located on the eastern side of the Rangpur–India–Nepal highway. Next to it is the imposing five-story, 1000-bed Rangpur Medical College Hospital, which adds to its importance in the local healthcare scene. The people lives in nearby city come to RpMC for seeking emergency medical facilities which was the reason for selecting the hospital for data collection.

Data collection: A total of 14354 birth data had been collected from RpMC. Information was gathered from the specified research location in accordance with the goals of the study. The list of participants was acquired from the corresponding section of the hospital and other healthcare professionals in the vicinity. A preliminary survey was undertaken to choose the participants and to obtain a comprehensive overview of the study area.

Environmental data: Data related to the environment, such as temperature, humidity, and pressure, were gathered by the NASA POWER satellite. Estimation was made regarding the impact of heat wave exposure on pregnant women in the last few weeks of their pregnancy before giving birth.

Statistical analysis: We employed the regression model, a commonly used method in survival analysis, incorporating time-dependent covariates to estimate the immediate impacts of heat waves. The usual regression model assumes that the hazard ratio (HR) remains constant over the whole time period. However, in our investigation, we incorporated time-dependent covariates into the regression model in the following manner:

$$h[t, X_{\mathrm{I}}, X_{\mathrm{i}}(t)] = h_0(t)\exp[\beta_{\mathrm{I}} X_{\mathrm{I}} + \beta_{\mathrm{d}} X_{\mathrm{i}}(t)]$$

In this given context, $h_0(t)$denotes the baseline hazard function, which signifies the rate of occurrence of an event for people when all explanatory factors are assigned a value of zero. The term X_I represents the values of the time-independent variables, such as the gender of the infant, the age of the mother, and the parity. The word $X_i(t)$ represents the values of time-varying variables, such as meteorological factors, at a specific time (t). The vectors and b_I and $b_d$are represent the model parameters that are linked to the variables that do not change over time and the covariates that do change over time, respectively (Cantor, 2003).

Results and Discussion

We conducted the time series analysis of the weather parameters of Rangpur region to understand the changes of the minimum temperature (Tmin), maximum temperature (Tmax), relative humidity (RH), wind speed and Rainfall (Fig. 2). As we can see in the result that a rising trend of temperature both maximum and minimum and a slightly decreasing trend of rainfall in the monsoon season has been observed. On the other hand, an unusual rising of rainfall has been observed in the pre winter season which can be turned into flooding in this region. The Tmax followed a slightly decreasing trend and there was a decreasing trend in the Tmin also.

Pregnancy Data: Fig.3 displays statistics regarding different categories of deliveries, encompassing regular deliveries, caesarean deliveries, and preterm deliveries, along with their corresponding rates. The overall delivery rate experienced a significant decline from May to October, which corresponded with elevated temperatures. This indicates a possible seasonal impact on the frequency of deliveries. In contrast, during the months of November to April, there was a higher rate of delivery, suggesting a potential link between colder temperatures and a rise in the number of deliveries. In 2020, there was a substantial increase in the frequency of preterm births. The rate showed a significant decline during the following two years, indicating enhancements in prenatal care or other factors that alleviate the occurrence of premature deliveries. The rate of Caesarean deliveries was notably elevated in 2019. Subsequent to that year, there was a decrease in the rate of caesarean deliveries. This tendency may be indicative of shifts in medical protocols, patient inclinations, or developments in the promotion and facilitation of natural childbirth. The data suggests that external influences, such as weather conditions, healthcare legislation, or public health campaigns, may be influencing these delivery patterns. The decline in premature and caesarean deliveries over time can be linked to improved healthcare practices and heightened awareness among pregnant women. Fig. 3 also demonstrates a distinct correlation between delivery rates and seasonal temperatures. It also showcases notable yearly fluctuations in premature and caesarean delivery rates, which may indicate overall trends and potential advancements in maternal and neonatal healthcare.

Relationship between temperature with premature delivery: Fig. 4 displays a probability map that investigates the correlation between premature birth rates and the highest recorded temperature (Tmax). The data demonstrates a noticeable correlation; as the temperature rises, there is a corresponding increase in the rate of preterm deliveries (PD). While the statistical significance of the association between premature birth rates and Tmax may not be robust, the evidence nevertheless indicates a noteworthy correlation. Temperature and premature deliveries exhibit a positive correlation, as indicated by the plot. greater temperatures are linked to greater rates of premature deliveries. This tendency indicates that temperature may play a role in causing premature births, potentially because of the stress and physiological impacts of heat on pregnant women. The rate of preterm deliveries exhibited a consistent level of stability across the years 2019, 2020, and 2021. Despite the persistent stability, the correlation between temperature and premature delivery rates remained unchanged during these years.

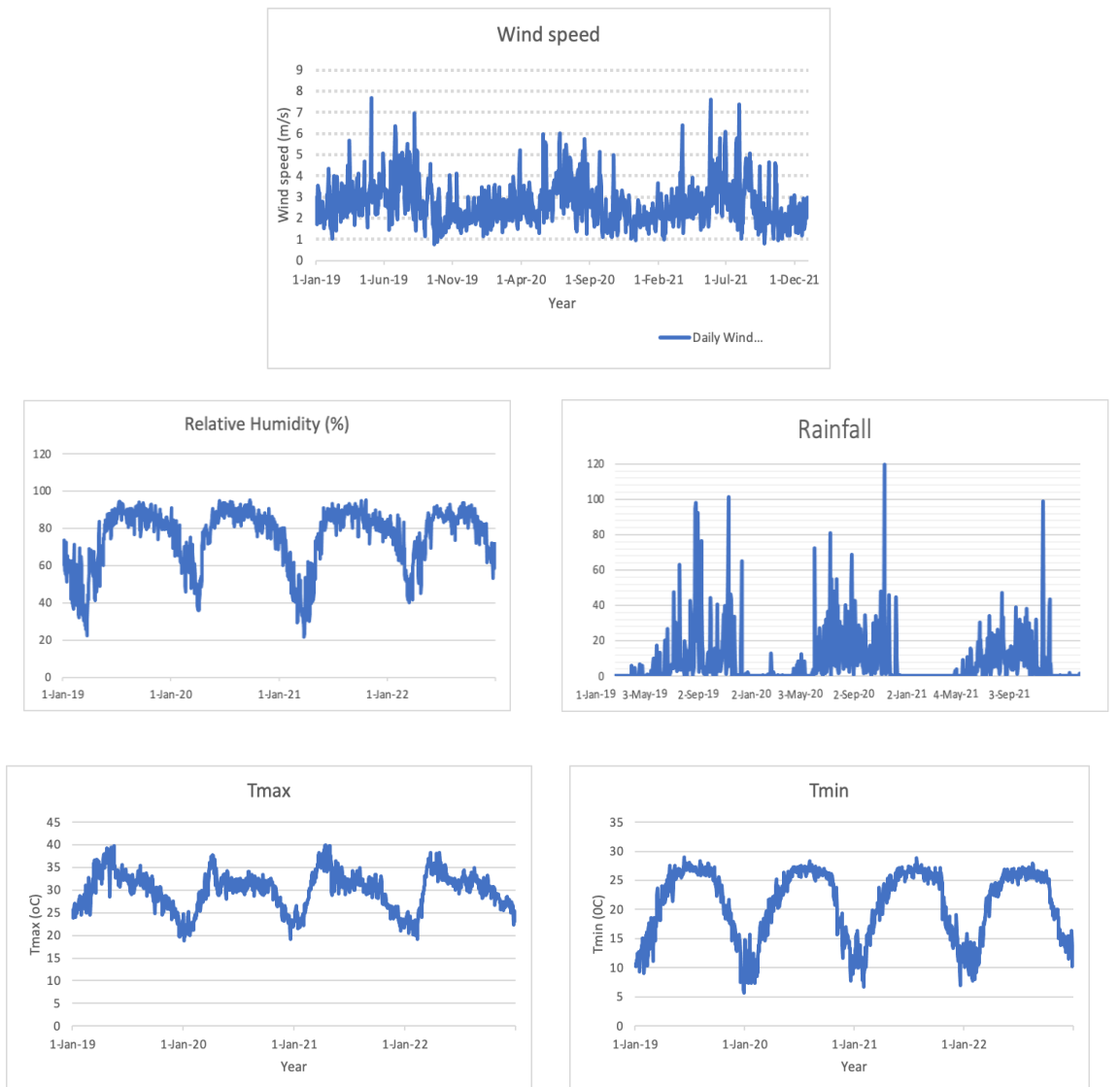

Fig. 2. Tmax, Tmin, Relative humidity, wind speed and rainfall of Rangpur station

Fig. 3. Normal delivery, rate of normal delivery, caesarean delivery, rate of caesarean delivery, premature delivery and rate of premature delivery

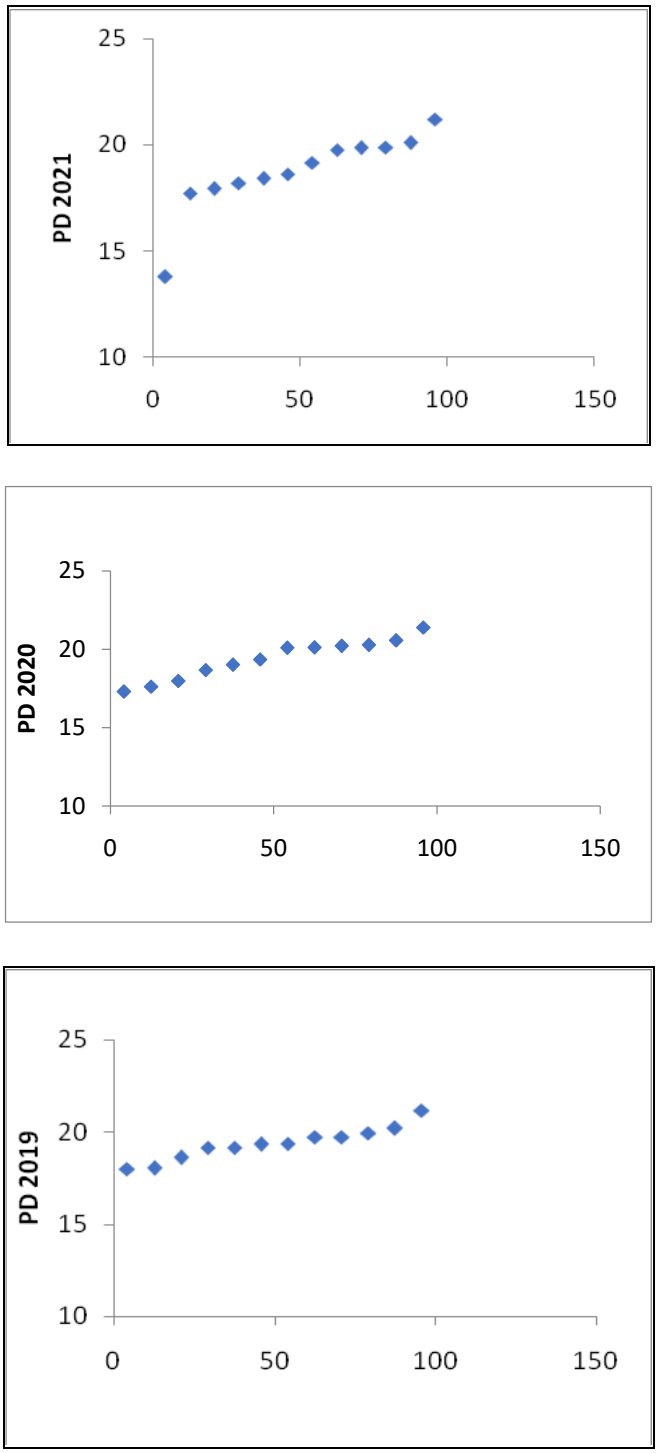

Fig. 4. Regression analysis of Tmax and premature delivery in the year 2019, 2020, 2021

This suggests that although other factors influencing premature delivery may have been stable, temperature continually had an impact. Fig. 4 demonstrates a distinct correlation between rising temperatures and the occurrence of premature deliveries, even though there is not a significant statistical association. This association highlights the need of taking environmental factors into account when assessing maternal health and indicates potential areas for intervention and additional investigation.

Discussion

Our study found that the temperatures during the years under investigation were lower compared to the same period in previous years. This decrease in temperature can be attributed to the effects of lockdowns implemented during the COVID-19 pandemic. These lockdowns led to a reduction in industrial activities and vehicular emissions, contributing to a cooler climate and making weather conditions more tolerable. Consequently, there were fewer days when temperatures exceeded the range of 28°C to 35°C. This phenomenon of reduced temperatures during lockdown periods has been observed in various cities worldwide (Abdulateef *et al*., 2022; Bonifacio-Bautista *et al*., 2022). For decades, there has been substantial evidence linking heatwaves to an increased risk of preterm births (Wang *et al*., 2013; Chersich *et al*., 2020). Our research also corroborated this association. However, within the specific time frame of our study, we did not observe a strong relationship between high temperatures and preterm births. This deviation can be explained by the cooler temperatures resulting from the COVID-19 lockdown measures (Pal *et al*., 2021), which mitigated the typical heat wave-related risks to pregnancy. Thus, the usual correlation between elevated temperatures and preterm births was not as pronounced during this period.

Rising temperatures as a consequence of climate change are inducing serious health effects, and pregnant women are among the most sensitive groups of people to heat exposure owing to their increased physiological requirement. There is less study on the health effects of climate change on pregnant women. The aim of the study is to fill this gap and provide important information that could help health workers educate pregnant women on heat exposure risk and how to implement preventive measures.

Conclusion

The heat exposure may help decrease the occurrence of premature births during periods of high temperatures. Although the existing evidence indicates a correlation, additional research is required to comprehend the fundamental mechanisms that are causing this relationship. Research could investigate the physiological reactions to high temperatures in pregnant women and how these reactions may lead to the onset of premature labor. Exploring supplementary environmental and socioeconomic factors could enhance our overall comprehension of patterns related to premature delivery.

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