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Investigating the Association between Preterm Birth and Fetal Characteristics with Seasonal Variation

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Abstract

Introduction: Premature birth (PTB) is a common cause of infant mortality and can lead to long-term complications and disorders. Considering that the prevalence of PTB may vary in the seasons, the changes in preterm birth rates during the seasons were investigated in this study, along with exploring the factors affecting the occurrence of preterm births.

Methods: In this cross-sectional study, data collected from pregnant women at Taleghani Hospital to investigate 140 cases of preterm births, concentrating on seasonal differences, maternal age, gravidity, previous abortion history, newborn gender, weight, umbilical cord pH, and the Apgar score measured at ten minutes birth.

Results: The study found that preterm birth rates vary by season, peaking in autumn at 29.3% and dropping to 19.5% in winter. The gender distribution of preterm infants was nearly equal, with a slight majority of boys. The average gestational age of mothers remained stable across seasons, and there was no significant difference in average baby weight among different maternal age groups. The average umbilical cord artery pH was 7.26, and the mean birth weight was 2,223 grams. Additionally, Spearman's analysis showed a positive correlation between gestational age and both ten-minute Apgar scores and birth weight. However, no significant associations were found between umbilical cord artery pH and gestational age, delivery type, or infant gender.

Conclusions: Preterm birth rates are not significantly affected by seasons, while longer gestational periods lead to heavier newborns and better Apgar scores. Umbilical cord pH remains unaffected by gestational age, delivery method, or baby gender.

INTRODUCTION

INTRODUCTION

Preterm birth (PTB), defined as a delivery before 37 weeks of gestation, and is a significant global health issue, with approximately 15 million cases occurring annually and a substantial burden on families and healthcare systems [1, 2]. Premature birth is responsible for 75% of perinatal mortality and more than half of morbidity throughout life [3, 4]. In 2020, the rate of preterm birth ranged from 4% to 16% among babies born in different countries. It is estimated that around 13.4 million babies were born preterm during that year. In 2015, PTB-related complications were the leading causes of child under-5 mortality and the second most common cause of child death after congenital abnormalities in the United States and China [5-7].

In high-income countries, although most hyperthermic babies survive, they are at a higher risk of developing neurological, respiratory, and digestive disorders [3, 8, 9]. According to reports, PTB has long-term consequences such as increased risks of cerebral palsy, impaired learning, visual disorders, hearing loss, and chronic noncommunicable diseases later in life [5]. In addition, PTB and its associated sequela have enormous negative impacts on the family and society [4, 6, 7].

The probability of premature birth can be influenced by various factors, including maternal age, underlying diseases, vitamin D level, allergies, viral and bacterial diseases, air temperature, and air pollution [4, 5, 10]. Today's societies face significant challenges related to air pollution, particularly during colder seasons when pollution levels are closer to the earth's surface due to

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climate change. This can increase the risk of pollutants entering the human body and causing respiratory, neurological, and digestive disorders [4].

Studies have identified seasonal patterns in PTB rates, with variations observed in different regions and populations. In the United States, for example, autumn has been identified as the peak season for preterm birth, while in the United Kingdom, Greece, and Japan, preterm birth rates show an annual pattern with two peaks, one in winter and the other in summer [1, 2]. These variations may be influenced by climatic factors such as temperature, humidity, and daylight length, as well as seasonal habits, religious practices, and social customs [1].

The possibility of premature birth may be higher in cold seasons or with more pollution due to the following factors: Changes in temperature and air pollution [4]. The prevalence of viral diseases in the seasons [11]. Seasonal changes can impact environmental factors like temperature and humidity, which have been linked to preterm births. Understanding these correlations can lead to targeted interventions that mitigate risks associated with adverse weather condition. Given the dangers associated with PTB for both the mother and the infant, a leading cause of infant mortality that can result in lasting health issues for mothers, this study examined the seasonal variations in PTB rates and delved into the factors influencing its occurrence.

METHODS

This is a cross-sectional study that aimed to investigate the frequency distribution of premature births during the years 2018-2019 at Taleghani Medical Education Center of Tehran affiliated to Shahid Beheshti University of Medical Sciences. The information was obtained from the files as well as the obstetrics and gynecology department. After extraction by the researcher, the results were confirmed by the second person. Although this study did not specifically focus on different cultural groups or exclude any particular cultural background, it is important to acknowledge the broad applicability of the findings within the sample. This study's data were collected from all patients admitted to this Hospital during the specified time period, reflecting a diverse patient population representative of the general demographic served by the hospital. Therefore, while the study does not include a formal cross-cultural validation, the results are relevant to a wide range of individuals within this context.

In this study, a complete enumeration sampling method was utilized to collect data on pregnant women who delivered before 36 weeks of gestation. The sample consisted of 140 individuals from a total of 148 women who gave birth prematurely (less than 37 weeks) at Taleghani Hospital over a two-year period. Mothers who delivered before 20 weeks of pregnancy, babies born weighing less than 500 grams, and multiple pregnancies were excluded from the study. This research focused on births that took place between 20 weeks and 36 weeks and 6 days of gestation, without examining the factors contributing to premature birth.

The inclusion criteria were as follows:

- Gestational age between 20 weeks and 36 weeks plus 6 days
- Single Pregnancy
- Weight of the larger newborn was 500 grams or more

Data Analysis

Statistical analysis was conducted using SPSS version 20 software in this study. This research employed a variety of techniques, including the Chi-square statistical test, ANOVA, T-test, and the bootstrap method, to analyze the data. The Chi-square statistical test and a 5% margin of error were used to evaluate the equality of preterm birth frequencies between seasons. ANOVA and T-test were used to compare means, while the bootstrap method was utilized to establish a 95% confidence interval to determine the likelihood and frequencies of occurrence.

Ethical Considerations

Throughout the study, the privacy and confidentiality of the patients were prioritized. All stages, including data collection and utilization, were conducted in a manner that protected the secrets and identities of the patients. The information obtained from the patients remained completely confidential and was treated with the utmost care. Moreover, full compliance with the principles of scientific ethics and trustworthiness has been ensured in the utilization of texts and information derived from other articles, magazines, and scientific sources. This study is based on the doctoral thesis of Aram Jafari, which has been approved by the ethics committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1398.920).

RESULTS

The average age of mothers who experienced preterm birth was 31.77. These mothers were categorized into five age groups: under 20 years (N=6), 20-24 years (N=11), 25-29 years (N=33), 30-34 (N=30), years, 35-39 years (N=29), and 40 years or older (N=14). The distribution was as follows in Table 1. The proportion of women who are pregnant for the first time (Gravid 1) was 30.9%, while the proportion of those who have been pregnant once (Gravid 2) was 30.9%, and more than 1 times (Gravid >2) was 38.2%. Concerning the mother's abortion history, the percentage of mothers who had no abortions was 73.2%, while 18.7% had one abortion, and 8.1% had more than one abortion, according to the study's findings.

Table 2 displays the percentages of PTB in various seasons and the Figure 1 displays PTB frequency in

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months. Also, the gender distribution of babies in the study was nearly even, with boys accounting for 51.2% and girls for 48.8%. Table 3 presents data on the occurrence and proportions of mothers' gestational ages. The statistical analysis revealed no significant differences in the average gestational age of mothers experiencing preterm births across different seasons of the year. Table 3 displays data on the frequency and distribution of mothers' gestational ages. In this study the neonates were categorized into five groups based on their weight (Table 4). The frequency of babies in each weight category is shown in Table 4. The average weight of babies was 2223 grams. Proportion of female newborns was 48.8% and male newborns was 51.2%.

According to the results, the average weight of babies born in different seasons is not significantly different from each other (p-value =0.416). The study found that the average weight of babies in different age groups of mothers is not significantly different from each other (p-value =0.346). Additionally, according to the study's findings, there is no correlation between the number of mothers' pregnancies and the weight of babies born (p-value =0.378). Furthermore, the average weight of male newborns is not significantly different from that of female newborns (p-value =0.536). However, the average weight of neonates in different gestational age categories is significantly different from each other (p-value < 0.001) (Figure 2). Moreover, according to Spearman's test, there is a significant positive correlation between gestational age and newborn weight with a correlation coefficient of 0.742 (p-value < 0.001). Based on the type of delivery, there was a notable distinction (p-value < 0.001) in the occurrence of cesarean section (75.6%) and vaginal delivery (24.4%) that is shown in figure 3. However, the T-test indicated that the weighted average of the two groups was not significantly different (p-value =0.812). Furthermore, there was no significant difference in the average gestational age between the vaginal and cesarean delivery groups (p-value = 0.152). On the other hand, the average age of mothers in the cesarean delivery group (32.77 years) and vaginal delivery group (28.62 years) showed a significant difference (p-value = 0.005).

The average pH of the umbilical cord in newborns was 7.26, with a standard deviation of 0.12 (The minimum pH recorded was 6.59, and the maximum pH was 7.47). The study found that there was no significant difference in the average pH of the arterial umbilical cord across different gestational age categories, as determined by the ANOVA test (p-value = 0.328) (Figure 4).

Table 1. The percentages of mothers who had PTB

Age group (years old)	percentages of mothers who had PTB
under 20	5.8%, (95% CI = 2.4%, 10.4%)
20 to 24	9.2%, (95% CI = 4.6%, 15.1%)
25 to 29	27%, (95% CI = 15.6%, 29.8%)
30 to 34	24.2%, (95% CI = 18.4%, 35%)
35 to 39	24.2%, (95% CI = 16.5%, 32.1%)
40 or older	11.7%, (95% CI = 6.2%, 17.8%)

Table 2. The percentages of PTB in various seasons

Seasons	percentages of PTB
Spring	24.4% (95% CI = 16.8%, 32.2%)
Summer	26.8% (95% CI = 19.0%, 35.1%)
autumn	29.3% (95% CI = 21.7%, 37.5%)
Winter	19.5% (95% CI = 12.7%, 26.9%)

Table 3. Gestational age

	Frequency	Percent	Minimum	Maximum
<24	1	0.8	0.0	2.5
24-27	11	8.9	4.1	14.8
28-31	12	9.8	4.8	15.4
32-33	22	17.9	11.5	24.8
34-36	77	62.6	53.7	71.1

Table 4. Neonate weight groups' frequency

	Frequency	Percent	Minimum	Maximum
<1000	9	7.3	3.2	12.3
1000-1500	12	9.8	4.7	15.6
1500-2000	23	18.7	12.0	25.6
2000-2500	31	25.2	17.5	33.1
2500-3000	30	24.4	17.1	31.7
>3000	18	14.6	8.7	21
total	123	100	100	100

Table 5. Apgar descriptive statistics

	Statistic	Minimum	Maximum
N	123	114	132
Min	0		
Max	9		
Mean	7.27	6.75	7.75
Std. Dev	2.889	2.387	3.291
N	123	114	132

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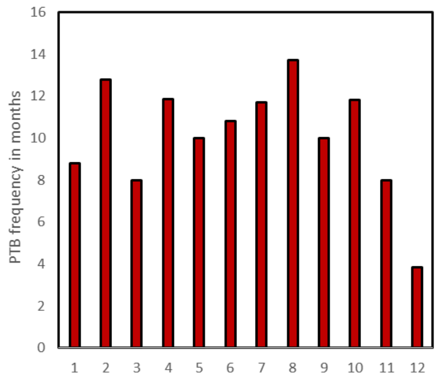

Figure 1. PTB frequency in months

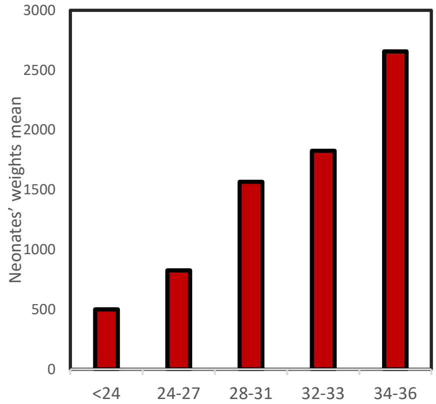

Figure 2. Neonates' weights mean in the gestational age categories

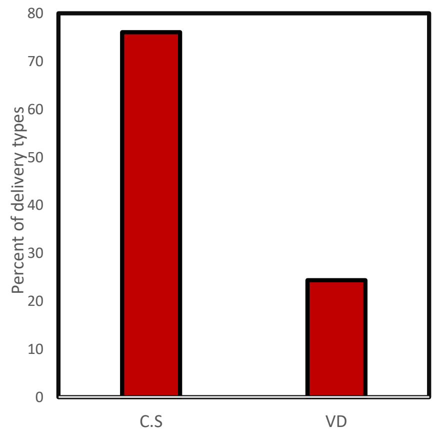

Figure 3. Percent of delivery types

Also, there was no clear association between gestational age and arterial umbilical cord pH, as indicated by Spearman's test (p-value = 0.396). Moreover, the average umbilical cord pH of newborns born in different seasons did not significantly differ from each other, as determined by the ANOVA test (p-value = 0.437). The study did not find a clear correlation (p-value = 0.376) between the age groups of mothers and arterial umbilical cord pH and similarly, there was no significant association between the sex of newborns and the pH of the arterial umbilical cord, as determined by the ANOVA test (p-value = 0.129). Also there was no significant correlation between the mode of delivery (vaginal or caesarean section) and the mean pH of the arterial umbilical cord in newborns, as indicated by the ANOVA test (p-value = 0.336).

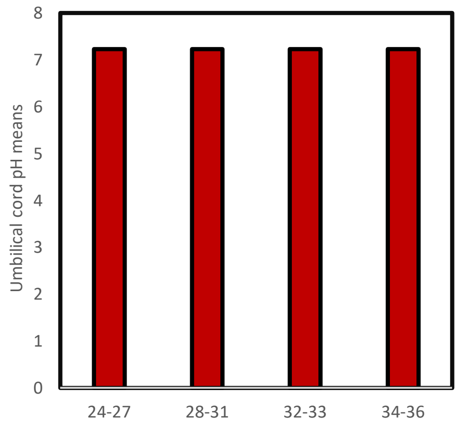

Figure 4. Umbilical cord pH means in the gestational age categories

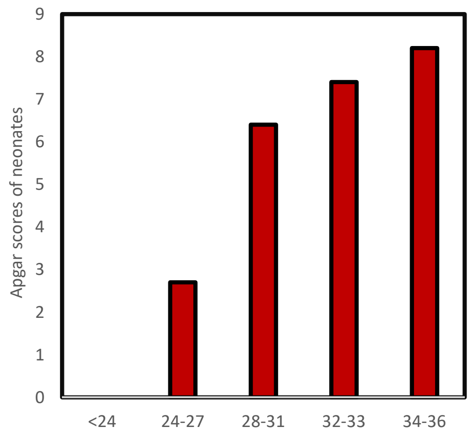

Figure 5. Apgar scores of neonates in different gestational age categories

Table 5 provided statistical descriptions of Apgar scores of newborns. The mean Apgar score of newborns did not show a significant difference in the age groups of mothers (p-value =0.517), and there was no significant difference in Apgar scores of male and female newborns (p-value =0.659). Additionally, there was no correlation coefficient between the Apgar score of newborns and the pH of the umbilical cord (p-value =0.519). Furthermore, there was no significant difference in Apgar scores between vaginal birth and cesarean birth (p-value =0.191).

As seen in figure 5, there is a significant difference between the average Apgar score of neonates were born in different gestational age categories in this study (p-value < 0.001), with a positive and a correlation coefficient of 0.466. Also, Neonatal Apgar scores showed a significant variation across different weight groups (p<0.001). Furthermore, there was a positive correlation between neonatal weight and Apgar scores, with a correlation coefficient of 0.5.

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DISCUSSION

Given the dangers associated with PTB for both the mother and the infant, a leading cause of infant mortality that can result in lasting health issues for mothers, this study examined the seasonal variations in PTB rates and delved into the factors influencing its occurrence. The results of this study confirms the direct relationship between gestational age and birth weight of babies.

This study found that the prevalence of preterm birth varied across seasons, with the highest rate in fall and the lowest rate in winter. According to a study conducted in the United States, conceptions occurring in late winter and early spring were the most common among births [12]. However, that study did not examine premature birth, while the present study included all causes of premature births and did not focus on a specific cause. Additionally, the mentioned study investigated the season of conception, and it was not possible to calculate the season in which the birth occurred since these births were premature and occurred between 20-36 weeks. Another study conducted in England found that the frequency of premature birth was different between seasons and was highest in winter [13].

A study in Norway found that fetuses conceived in July had the lowest rates of preterm birth and early preterm birth, while those conceived in December had the highest rates [1]. This finding is consistent with seasonal patterns observed in other countries. In addition to seasonal variations, the review highlights the importance of considering nondifferential errors in assigning the date of the last menstrual period (LMP) as potential confounders in studies examining the relationship between season and preterm birth [14]. Proper avoidance of these errors is crucial for accurate analysis.

Another study conducted in the United States reported the prevalence of premature births occurring in the same seasons [15] but did not investigate the causes of premature birth. However, the studies mentioned earlier were conducted in developed countries, which could be an influential factor in this field. In contrast, a study conducted in Bangladesh found that the prevalence of premature birth was lowest in winter and highest in autumn [16]. The current study's findings follow this pattern to some extent, with the lowest prevalence in the winter season (5.83%) and the highest in the autumn season (9.13%). However, the results of the statistical tests showed that this difference was significant, and there was no significant difference in the prevalence of premature birth between seasons with a p-value greater than 0.05.

The development level of societies may be a reason for the difference in the results of the studies conducted in different countries compared to our study. Differences in socio-economic status may also contribute to the variations in the results of the studies, as premature birth is more common in the lower socio-economic class [17].

Exposure of pregnant women to high or low temperatures can increase the likelihood of premature birth [18]. Since air temperature varies across different seasons, it is likely to be a contributing factor to the difference in the prevalence of premature birth in different seasons. Additionally, the difference in temperature in different geographical latitudes and countries can be one of the reasons for the variation in the results of similar studies. These factors, including temperature and geographical location, may explain the different prevalence of premature birth in different seasons and the variation in the results of this research compared to other studies [19-21].

The present study revealed that there is a correlation between gestational age and birth weight of preterm babies, and the birth weight increases with increasing gestational age. This result is consistent with the other findings [22-24].

The correlation between the Apgar score of the 5th minute of the baby and gestational age was observed in Catlin E's study [25], which is consistent with the findings of the present study. Birth weight has been proposed as a factor influencing gestational age, and gestational age, Apgar score, and birth weight of the baby are interrelated factors. Increasing gestational age as an independent factor can significantly impact the baby's Apgar score, but since gestational age also has a positive effect on the baby's weight, it can be a confounding factor [22, 24].

Furthermore, the Apgar score of newborns can be influenced by the method of delivery, whether it is vaginal or cesarean. However, based on the statistical analysis conducted in our study, there is no significant difference observed in the Apgar scores between these two delivery categories. These findings are consistent with the results of Catlin E's study, which also examined the relationship between Apgar scores and gestational age [25]. Moreover, our study suggests that birth weight may play a role in influencing gestational age, and all three factors - gestational age, Apgar score, and birth weight - are interconnected. It is worth noting that increasing gestational age, as an independent factor, can have a significant impact on the baby's Apgar score. However, since gestational age also has a positive effect on the baby's weight, it can potentially act as a confounding factor. The search results provide additional information on the association between Apgar scores, delivery mode, and gestational age, as well as the impact of maternal and fetal factors on birth outcomes [22, 26-28].

The study found that the average pH of the umbilical cord in different gestational age groups was normal and did not show any significant difference (p-value = 0.328), which is consistent with the findings of some previous studies [22, 29]. Additionally, umbilical cord

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pH was not found to have a significant relationship with mode of delivery [29, 30]. Furthermore, umbilical cord pH was not found to have a significant relationship with other variables such as the mother's age, baby's gender, and season of birth [25, 28, 29, 31, 32].

Limitations

This study was conducted within a single hospital, which may limit the generalizability of the findings to other settings or populations. Additionally, while the study included a random sample of patients admitted during the specified period, it did not control for potential confounding factors such as socioeconomic status, access to prenatal care, or environmental influences, which could impact the results. Future studies should consider a larger, more diverse population across multiple sites to validate these findings further and explore additional variables that may affect preterm birth outcomes.

CONCLUSION

The prevalence of preterm birth does not show a significant relationship with the seasons. The present study confirms the direct relationship between gestational age and birth weight of babies. However, the arterial pH of the umbilical cord is not affected by variables such as gestational age, type of delivery, and the baby's gender. This study emphasizes the need for further research to understand the potential environmental causes of preterm birth and the role of seasonality in this complex clinical syndrome. Identifying and addressing modifiable risk factors could help reduce the global burden of preterm birth and improve outcomes for affected infants and their families.

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ETHICAL CONSIDERATION

This study is based on the doctoral thesis of Aram Jafari, which has been approved by the ethics committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1398.920).

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AUTHOR CONTRIBUTION

Authors had equal contribution to designing study, collecting data, revising the initial draft, and approving the final draft.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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