



RESEARCH ARTICLE

A Study of Time Domain Parameters of Heart Rate Variability in Females in the Latent Phase of Labor and Postpartum Period in a Tertiary Care Centre of Central India

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ABSTRACT

Background: Pregnancy and labor are associated with significant autonomic nervous system adaptations that facilitate maternal and fetal well-being. Heart rate variability (HRV) is a non-invasive marker of autonomic regulation and provides valuable insights into sympathetic and parasympathetic balance. However, changes in time-domain HRV parameters during the latent phase of labor and the immediate postpartum period remain inadequately characterized.

Aim: To evaluate and compare time-domain parameters of heart rate variability in females during the latent phase of labor and the postpartum period.

Methods: This observational study was conducted at Bundelkhand Medical College, Sagar, over a period of three months. A total of 100 healthy term pregnant women in the latent phase of labor were enrolled. HRV recordings were obtained during the latent phase and repeated 48 hours postpartum. Time-domain parameters including mean RR interval, SDNN, RMSSD, NN50, and pNN50 were analyzed and compared.

Results: Significant increases in SDNN, RMSSD, NN50, and pNN50 were observed during the postpartum period compared with the latent phase of labor ($p < 0.001$). Mean heart rate decreased significantly postpartum, indicating restoration of parasympathetic activity. The findings suggest a shift from sympathetic predominance during labor to improved autonomic balance following delivery.

Conclusion: The postpartum period is associated with significant improvement in HRV parameters, reflecting recovery of autonomic function after labor. Time-domain HRV analysis may serve as a useful tool for assessing maternal autonomic adaptations during the peripartum period.

Keywords: Heart rate variability, Labor, Postpartum period, Autonomic nervous system, SDNN, RMSSD.

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INTRODUCTION

In order to sustain foetal growth and development, pregnancy is a special physiological condition marked by significant cardiovascular, hormonal, and autonomic changes. During labour, these alterations intensify, and after delivery, they progressively revert to pre-pregnancy levels. Changes in autonomic balance may have an impact on mother outcomes throughout labour and the postpartum period, as the autonomic nerve system is essential in maintaining cardiovascular homeostasis during these transitions. A trustworthy, non-invasive technique for evaluating autonomic nervous system activity is heart rate variability (HRV). Beat-to-beat variations in heart rate caused by the dynamic interplay between sympathetic and parasympathetic effects on the sinoatrial node are represented by HRV. Increased HRV indicates improved cardiovascular flexibility and improved parasympathetic modulation, while decreased HRV is typically linked to sympathetic predominance.[1]

Changes in autonomic function during pregnancy are caused by increased metabolic demands, hormonal changes, plasma volume expansion, and cardiovascular adaptations. As gestation progresses, sympathetic activation increases and parasympathetic activity decreases, according to several studies. Uterine contractions, discomfort, anxiety, and elevated catecholamine release are all signs of labour, a time of extreme physiological stress that may further affect autonomic regulation. Cervical dilatation steadily advances during the latent phase of labour, which is the first step of the first stage of labour. Maternal stress and cardiovascular demand are rising during this phase. On the other hand, the postpartum phase is marked by quick hormonal and hemodynamic changes that speed up the healing process following pregnancy and deliveries. Maternal autonomic adaptation can be better understood by evaluating HRV during these times.[2]

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One of the most popular methods for evaluating HRV is still time-domain analysis. Various features of autonomic regulation and cardiac vagal activity are reflected by parameters including SDNN, RMSSD, NN50, and pNN50. Variations in these metrics could be a sign of changes in the sympathetic-parasympathetic balance during childbirth and recuperation. There is little information on HRV alterations in Indian women during labour and the early postpartum period, despite the increased interest in maternal autonomic function. In order to assess time-domain HRV parameters in females during the latent phase of labour and compare them with values obtained during the postpartum period, the current study was conducted.[3]

MATERIALS AND METHODS

Study Design

Observational comparative study.

Study Setting

Department of Physiology in collaboration with Department of Obstetrics and Gynecology, Bundelkhand Medical College, Sagar, Madhya Pradesh.

Study Duration

Three months.

Sample Size

100 pregnant women.

Inclusion Criteria

- Age 18–35 years.
- Singleton term pregnancy (37–40 weeks).
- Latent phase of spontaneous labor.
- Normal fetal status.
- Willingness to participate.

Exclusion Criteria

- Hypertensive disorders of pregnancy.
- Gestational diabetes mellitus.
- Cardiac disease.
- Thyroid disorders.
- Multiple pregnancy.
- Use of medications affecting autonomic function.

Data Collection

- HRV recordings were obtained using a standardized POLAR H 10 Heart sensor analysis system.

Recording Times

- During latent phase of labor.
- At 48 hours postpartum.
- Time-Domain Parameters Evaluated
- Mean Heart Rate (HR)
- Mean RR Interval
- SDNN (ms)
- RMSSD (ms)
- NN50
- pNN50 (%)

Statistical Analysis

- Data were analyzed using SPSS version 26.
- Paired t-test.
- Mean $\pm$ SD.
- $p < 0.05$ considered statistically significant.

RESULTS

The mean age of participants was 25.8 years. More than half of the participants were primigravida.

All time-domain HRV parameters improved significantly during the postpartum period. Heart rate decreased significantly, while parasympathetic indices increased.

Higher heart rates were significantly associated with lower

Table 1: Demographic Characteristics

Variable	Mean $\pm$ SD
Age (years)	25.8 $\pm$ 3.9
Gestational Age (weeks)	38.7 $\pm$ 1.1
BMI (kg/m ²)	26.4 $\pm$ 2.8
Primigravida (%)	56
Multigravida (%)	44

Table 2: Comparison of Time-Domain HRV Parameters

Parameter	Latent Phase	Postpartum	p-value
Heart Rate (bpm)	92.6 $\pm$ 8.5	78.4 $\pm$ 7.2	<0.001
Mean RR Interval (ms)	648 $\pm$ 72	768 $\pm$ 65	<0.001
SDNN (ms)	32.8 $\pm$ 8.1	48.5 $\pm$ 9.4	<0.001
RMSSD (ms)	24.7 $\pm$ 6.3	42.8 $\pm$ 8.6	<0.001
NN50	18.5 $\pm$ 7.2	44.3 $\pm$ 12.1	<0.001
pNN50 (%)	5.2 $\pm$ 2.4	14.8 $\pm$ 4.9	<0.001

Table 3: Correlation Between Heart Rate and HRV Parameters

Parameter	Correlation (r)	p-value
SDNN	-0.52	<0.001
RMSSD	-0.61	<0.001
pNN50	-0.57	<0.001

HRV values, indicating sympathetic predominance during labor.

DISCUSSION

The current study assessed how women's heart rate variability changed over time during the latent phase of labour and the postpartum phase. Significant changes in autonomic nervous system activity were found, with sympathetic predominance during labour and restoration of parasympathetic regulation after delivery. Significant cardiovascular and neuroendocrine changes are linked to pregnancy and labour. Increased sympathetic nervous system activity during labour is a result of pain, anxiety, uterine contractions, and elevated catecholamine levels. The higher hemodynamic and metabolic demands of labour need this physiological reaction. Increased sympathetic activation is supported in the current investigation by the noticeably greater heart rate seen during the latent phase.[4]

The substantial decrease in heart rate during the postpartum period was one of the most striking discoveries. Improved autonomic balance is a result of reduced catecholamine levels, alleviation from labor-related stress,

and a slow return to normal cardiovascular physiology after delivery. Increased parasympathetic influence on heart rhythm is further supported by the postpartum rise in mean RR interval. During the postpartum phase, time-domain HRV measurements showed a noticeable improvement. Following delivery, there was a notable increase in SDNN, which measures total autonomic variability. This result implies enhanced autonomic flexibility and cardiovascular regulation recovery. Studies assessing the autonomic function of mothers during the peripartum period have shown similar findings.[5]

An recognised indicator of vagal activity, RMSSD, also markedly increased after giving birth. The significant increase in RMSSD suggests that parasympathetic regulation has returned after childbirth. Greater physiological resilience and improved cardiovascular health are typically linked to increased vagal activation. Following delivery, the NN50 and pNN50 values exhibited the most relative increase. Both indices mainly show parasympathetic activation and short-term heart rate variability. Their notable increase during the postpartum phase suggests that autonomic control has quickly recovered and heart rhythm regulation has returned to normal.[6]

Significantly negative correlations between heart rate and HRV parameters were found via correlation analysis. SDNN, RMSSD, and pNN50 levels were lower in women with faster heart rates. Because sympathetic stimulation both raises heart rate and decreases beat-to-beat variability, these results are physiologically feasible. The results of the study lend credence to the idea that labour is a temporary autonomic stress state marked by sympathetic dominance. Increased HRV results from autonomic modulation gradually shifting towards parasympathetic predominance after delivery. These alterations most likely represent the restoration of cardiovascular homeostasis and recuperation from physiological stress brought on by labour.[1]

Prospective measurement and evaluation of several HRV measures in the same people are among the study's strengths. The study does have some drawbacks, though. Follow-up was restricted to the early postpartum period, and frequency-domain HRV characteristics were not assessed. Furthermore, variables including emotional state, sleep quality, and pain perception were not measured. Notwithstanding these drawbacks, the results offer insightful information about the autonomic adjustments made by mothers throughout labour and the postpartum phase. A helpful non-invasive method for tracking a

mother's cardiovascular and autonomic health throughout the peripartum period is time-domain HRV analysis.[2]

CONCLUSION

Significant changes in autonomic nervous system activity between the latent phase of labour and the postpartum period are shown in this study. Higher heart rates and lower HRV indices were seen in latent phase women, suggesting a greater sympathetic predominance during labour. Significant increases in SDNN, RMSSD, NN50, and pNN50 were noted after delivery, indicating enhanced autonomic balance and parasympathetic activity recovery. The results demonstrate how maternal cardiovascular adaptation is dynamic during the peripartum phase. Time-domain HRV values can be sensitive markers of physiological stress and recovery and offer important information about autonomic control. The notable postpartum benefits point to the return of autonomic homeostasis after childbirth.

Monitoring maternal health, identifying women at risk for autonomic dysfunction, and assessing postpartum recovery could all benefit from routine HRV screening. To gain a better understanding of the clinical importance of HRV alterations during pregnancy, labour, and the postpartum period, more research including bigger populations, frequency-domain analysis, and long-term

follow-up is advised.

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