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Effects of maternal positions in electronic fetal monitoring: a randomised controlled trial

Tuğba Yilmaz Esencan[1], Ayça Demir Yildirim[1*] and Ebru Sağiroğlu[1]

Abstract

Background During electronic fetal monitoring, the positions provided to mothers by perinatal nurses and midwives are essential for ensuring maternal comfort, as well as maternal and fetal well-being. This study aimed to investigate the impact of various maternal positions during electronic fetal monitoring on maternal and fetal health.

Methods This study was conducted in a randomized controlled trial design. The study included 240 pregnant women at 34–40 weeks of gestation. The data were collected via a descriptive form for pregnant women and a general comfort questionnaire.

Results A statistically significant difference was found between cardiotocography monitoring positions in terms of cardiotocography duration, basal heart rate, and acceleration during cardiotocography ($p < 0.05$). The study indicated that the semi-Fowler position has a statistically significant effect on maternal comfort ($t = 3.834$, $p < 0.05$). It was also noted that the semi-Fowler position created a 0.911 rate of increase in general comfort.

Conclusions The use of the semi sitting position as an alternative to the left lateral position in the clinic is worthy of recommendation, and in pregnant women with a high body mass index, the semi sitting position should be preferred during fetal monitoring. It is recommended that the semi-Fowler position be preferred for fetal monitoring in pregnant women with a high BMI, and further research should be conducted to make these positions standard in the clinic.

Clinical Study Registration Since our research constituted a randomized controlled study, it was registered on the ClinicalTrials.gov website under ClinicalTrials ID No. NCT05863156||https://www.clinicaltrials.gov/) with the Clinical Trial Registry (30.12.2021/{1})

Trial registration In addition, clinical trials were registered (NCT05863156||https://www.clinicaltrials.gov/) with the Clinical Trial Registry (30.12.2021/{1})).

Keywords Fetal monitoring, Patient comfort, Maternal health, Midwifery, Randomized controlled study

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*Correspondence:
Ayça Demir Yildirim
ayca.demir@uskudar.edu.tr; ayca.demiryildirim@uskudar.edu.tr
[1]Faculty of Health Sciences, Department of Midwifery, Üsküdar University, İstanbul, Turkey

Background

Reducing maternal mortality and morbidity rates during pregnancy, as well as those of neonates, is achievable through antenatal monitoring [1]. Cardiotocography (CTG), also known as the nonstress test (NST), plays a crucial role in clinically monitoring fetal movements, assessing accelerations in the fetal heart rate (FHR), and predicting risks during pregnancy and labor [2]. CTG is an assessment tool that uses an electronic fetal monitor to record FHR data continuously for evaluating fetal health, typically starting from the 32nd week of gestation [3–9]. This test has become almost routine in antenatal monitoring. Normal cardiotocographic parameters are recognized worldwide and have been validated. Electronic fetal monitoring (EFM) enables the assessment of fetal risk of intrauterine death or neonatal complications, facilitating close monitoring of high-risk pregnancies and the early detection of fetal hypoxia [4, 5].

CTG is widely employed globally in pregnancy and labor monitoring because of its noninvasive nature, accessibility, and user-friendliness.4 Short- or long-term changes in the fetal heart rate can be influenced by various maternal and fetal factors [4, 6]. These factors include the pregnant woman's age, hunger state, uterine contractions, and position during CTG. Electronic fetal monitoring allows simultaneous assessment of FHR and uterine contractions, enabling early diagnosis of fetal asphyxia or ischemia and the implementation of risk mitigation measures [6]. This study focuses primarily on the effects of positioning the pregnant woman optimally during CTG.

It is recognized globally that only a limited number of positions, such as side-lying or semi sitting (semi-Fowler) positions, are commonly used during fetal monitoring [1, 8, 9]. In Turkey, pregnant women are typically placed in the left lateral position [6]. The few studies conducted in this area highlight the importance of examining different positions [1, 6, 7]. The supine position is discouraged during EFM because of reduced fetal oxygenation and an increased risk of maternal hypotension [1, 7–9]. The recommended positions should ensure effective uterine perfusion and fetal heart rate optimization while preventing hypotension [7]. However, these recommended positions may restrict the patient's movement and comfort [7, 8, 10]. Therefore, it is essential to explore various positions, including the right semi-Fowler, left semi-Fowler, and sitting positions, during electronic fetal monitoring to improve maternal comfort, provide choices to pregnant women, and enhance fetal well-being [10].

The American College of Obstetricians and Gynecologists (ACOG) states that electronic fetal monitoring can be conducted in the semi-Fowler position, where the individual lies on their back with their head elevated at a 30-degree angle, or in the sitting or lateral side-lying position [8, 9]. In its latest recommendation for EFM in 2015, The International Federation of Gynecology and Obstetrics (FIGO) recommends side-lying, semi-sitting and upright positions as preferable alternatives [11]. The woman's position during EFM greatly influences the indication of fetal reactivity [4]. Few articles in the literature focus on less commonly used positions and assess the utilization and effects of right and left lateral positions, semi-Fowler positions, and sitting positions [1]. Emphasis has been placed on the need for investigations into different positions to ensure maternal comfort and maternal and fetal well-being [4, 10] Thus, this study was conducted to evaluate the impact of various positions on maternal comfort, maternal blood pressure, and fetal health during antenatal electronic fetal monitoring. In this study, the left lateral position, the position most recommended in clinical practice to optimise maternal-fetal circulation, was chosen for the control group. However, the semi-Fowler position, which is endorsed by authoritative guidelines such as ACOG and FIGO [9, 11], was also examined in the study and allowed the effects of alternative positions on maternal comfort and fetal welfare to be evaluated.

Research hypotheses

H1 The semi-Fowler position during electronic fetal monitoring results in significantly greater maternal comfort than the left lateral and right lateral positions do.

H2 Compared with the left lateral and right lateral positions, the semi-Fowler position results in a significantly shorter duration of cardiotocography (CTG).

H3 Compared with the left lateral and right lateral positions, the semi-Fowler position will produce statistically significant improvements in fetal health indicators, such as fetal heart rate acceleration and fetal movements, during CTG.

H4 Maternal systolic and diastolic blood pressure will vary significantly on the basis of maternal position during CTG, with the semi-Fowler position providing a more stable blood pressure profile than the left lateral and right lateral positions do.

Methods

Study Design This study was conducted at the pregnancy monitoring polyclinic of an obstetric hospital in Istanbul between December 2021 and January 2023. This study employed an experimental design as a randomized controlled trial with two intervention groups and one control group to evaluate the impact on maternal and fetal health on the basis of the position of the pregnant woman during electronic fetal monitoring. The study analysis followed

the Consolidated Standards of Reporting Trials (CONSORT) reporting guidelines.

Study Population: The study population consisted of 12,000 individuals registered for electronic fetal monitoring at a hospital obstetrics polyclinic in the past year. The G*Power 3.1.9.4 program was used to calculate the study sample size. The calculations indicated an effect size of d:0.5 (medium) at a confidence interval (CI) of 95%. The sample size was initially set at 210 individuals but was increased by 15% to 240 to account for potential participation refusals.

The inclusion criteria for participants were as follows: were over the age of 18, were in the late third trimester (34th-40th gestational week), had fetal biometric measurements corresponding to the 34th-40th gestational week, had a single fetus, had no maternal or fetal risk factors affecting pregnancy, had normal vital signs before the procedure, were not fasted for more than 2 h before the procedure, and agreed to the suggested position. The reason for the selection of pregnant women between the 34th and 40th weeks of gestation was that routine CTG (cardiotocography) was recommended to be performed from the 34th week onwards to monitor fetal health in line with the prenatal care guidelines of the Ministry of Health in Turkey [12]. Pregnant women who did not meet the inclusion criteria were excluded from the study. Completion of the CTG procedure in less than 20 min and incomplete data entry were set as exclusion criteria.

Randomization: Participants were assigned to the intervention and control groups via a computer-generated random sequence from random.org (www.randomizer.org). Allocation concealment was maintained by an independent researcher who was not involved in the data collection process. A total of 240 participants were randomly allocated into three groups: 60 participants in the right lateral position (Intervention 1), 60 in the semi-Fowler position (Intervention 2), and 120 in the left lateral position (Control group).

Data collection tools

Information questionnaire

This questionnaire comprises 35 items covering pregnant women's sociodemographics; obstetric data; and vital signs (blood pressure-BP, pulse, temperature, and oxygen saturation-SPO_2) before, during, and after CTG. Fetal monitoring findings were also assessed four times during the procedure (0–5 min, 6–10 min, 11–15 min, and 16–20 min), along with the position of the pregnant woman.

General comfort questionnaire-short form (GCQ-SF)

Developed by Kolcaba in 2006, this questionnaire measures comfort across the subdimensions of relief, ease, and transcendence. It contains both positive and negative items, with negative items scored in reverse. Scores are calculated by dividing the total score by the number of items, resulting in values between 1 (low comfort) and 6 (high comfort) [13–15].

Procedure

Electronic fetal monitoring at the hospital was performed by midwives and nurses, with each session lasting 20 min. Pregnant women were assigned numbers upon arrival, and random assignment to groups was performed with the support of an independent clinic midwife and nurse, ensuring a single-blinded design. The same midwives and nurses conducted all the procedures throughout the study.

The intervention group, comprising 120 pregnant women, was further divided into two subgroups: 60 women were assigned to the right lateral position (Intervention 1), and 60 women were assigned to the semi-Fowler position (Intervention 2). The head of the bed was raised 45° in the semi-Fowler position. The positions were explained to the participants, and vital signs were monitored at regular intervals before, during, and after the CTG procedure.

The control group, which also consisted of 120 women, adhered to the clinic's routine practice of the left lateral position. All women in this group were placed in the left lateral position, with the remainder of the procedures conducted in the same manner as those used for the intervention groups. Researchers supervised all monitoring and follow-up assessments (Fig. 1).

Statistical analysis

Data analysis was performed via the SPSS 24.0 (IBM Statistics, PASW Inc., Chicago, IL, USA) program. The distribution of the data was examined with the Kolmogorov–Smirnov test. Descriptive statistics are presented as numbers, percentages, means, medians, standard deviations, and minimum and maximum values. Variables were analyzed via chi-square, ANOVA, and Kruskal–Wallis tests on the basis of their distribution. The Kruskal–Wallis hypothesis test was used to assess differences between groups in repeated measurements. Scale scores and relationships between positions were evaluated via simple linear regression analysis. The statistical significance threshold was set at $p<0.05$.

Ethical approval and informed consent

This research received approval from the clinical research ethics board of the conducting hospital (Decision No. 123; Date: 18.12.2019). Written permission was obtained for the use of the scale In this study, informed consent forms were obtained from the participants in accordance with the Declaration of Helsinki, which is a guideline for all experiments conducted on humans and/or using

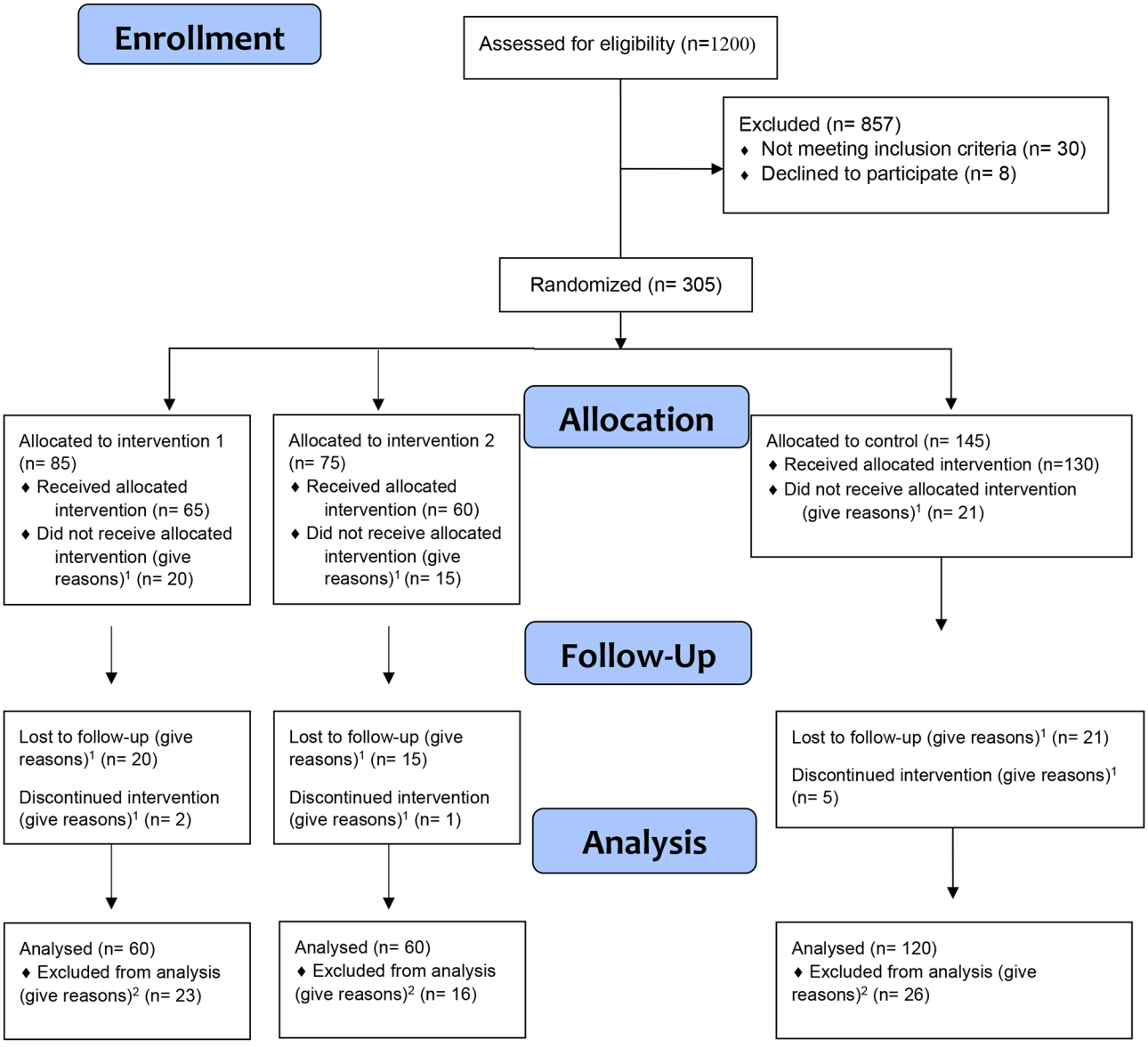

Fig. 1 CONSORT flow diagram

human data in research, and the research was carried out in accordance with the regulations.

Results

The CTG was conducted with 60 participants in the right lateral position (Intervention 1), 60 in the semi-Fowler position (Intervention 2), and 120 participants in the left lateral position (control group). Table 1 presents the correlations between CTG positions and the sociodemographic and obstetric features of pregnant women. Among the sociodemographic features, a statistically significant relationship was observed between CTG positions and place of residence, number of miscarriages, and previous CTG positions.

Various CTG parameters were monitored to assess maternal and fetal health. Table 2 presents the results, highlighting any differences in CTG parameters based on the positions of pregnant women. A statistically significant difference was found between CTG monitoring positions concerning CTG duration (group 1: 20.24±1.99, group 2:18.46±2.82 and group 3: 20.25±3.07), basal heart rate maximum at 11–15 min (group 1:140.18±9.82, group 2: 143.87±8.88 and group 3: 138.16±11.48), and the presence of accelerations during the CTG maximum at 11–15 min (group 1:1.39±1.14, group 2: 1.74.87±1.10 and group 3: 1.40±1.08) ($p<0.05$). Notably, the mean values for the semi-Fowler position (Intervention 2) were significantly different from those of the other positions. Additionally, significant differences were observed

Table 1 Comparison of CGT positions in terms of sociodemographic and obstetric features

Variables		Right Lateral Side-Lying Position		Semi-Fowler Position		Left Lateral Side-Lying Position		Test Score	p
		n	%	n	%	n	%		
Age ($\bar{X}$±SD[2], 31.62 ± 4.46)	19–34	42	68.9	46	77.4	95	79.8	3.795**	0.391***
	35 and over	18	31.1	14	22.6	25	20.2		
BMI[3]	18 and below (underweight)	-	-	-	-	-	-	1.104**	0.899*
	19–24 (normal)	15	26.2	20	32.3	31	26.1		
	25–29 (overweight)	32	52.5	27	45.2	62	51.3		
	30 and over (obese)	13	21.3	13	22.6	27	22.7		
Civil Status	Officially Married, Partner in a Civil union	58	96.7	60	100	116	96.6	2.025**	0.375*
	Partner in a Civil Union, Not Officially Married	2	3.3	0	0.0	4	3.4		
Education	Primary School	12	20.0	7	11.3	22	18.6	0.310**	0.621*
	Middle School	9	15.0	15	24.2	22	18.6		
	High school	19	30.0	18	30.6	37	30.5		
	Associate Degree	6	10.0	7	11.3	12	9.3		
	Bachelor's Degree	11	18.3	12	21.0	26	22.0		
	Graduate Degree	4	6.7	1	1.6	1	0.8		
Employment	Employed	15	25.0	10	19.4	33	25.6	0.940**	0.628*
	Unemployed	45	75.0	50	80.6	87	74.4		
Place of Residence	Province	43	73.7	55	91.8	87	73.7	7.285**	**0.004***
	District	17	26.3	5	8.2	33	24.6		
	Village	0	0.0	0	0.0	2	1.7		
Income Level	Income greater than expenditure	5	8.3	3	4.8	11	9.2	0.465**	0.269*
	Income equal to expenditure	34	56.7	33	56.5	65	54.6		
	Income less than expenditure	21	35.0	24	38.7	44	36.1		
Social Security	Yes	51	85.0	51	85.2	101	85.3	0.004**	0.998*
	No	9	15.0	9	14.8	19	14.7		
Any medical problem	Yes	4	6.7	5	8.1	10	6.8	0.085**	0.438*
	No	56	93.3	55	91.9	110	93.2		
Pregnancy	Planned	48	76.5	51	82.3	92	76.5	5.825**	0.054*
	Unplanned	12	23.5	11	17.7	28	23.5		
Wanted Pregnancy	Yes	55	93.4	58	95.2	115	958	0.086**	0.446*
	No	5	6.6	2	4.8	5	42		
Number of pregnancies	Primipara	13	20.3	25	37.5	42	33.3	4.536**	0.104
	Multipara	47	79.7	35	62.5	78	67.7		
Ending Week of Last Pregnancy	36th week or earlier	31	51.7	37	62.9	66	55.9	1.085**	0.167*
	37th-40th week	29	48.3	23	37.1	50	41.5		
	41st week or later	0	0.0	0	0.0	4	2.5		
Number of living children	None	17	28.8	25	39.3	46	39.3	0.025**	0.467*
	1–3	41	69.5	35	60.7	70	57.3		
	4 or more	2	1.7	0	0.0	4	3.4		
Number of Miscarriages	None	43	72.9	43	72.7	104	86.3	9.306**	**0.002***
	1–2	15	25.4	12	18.2	16	13.7		
	3 or more	2	1.7	5	9.1	0	0		
Number of Wanted Miscarriages	None	51	86.2	48	82.1	109	91.5	3.142**	0.051*
	1–3	8	12.1	12	17.9	11	8.5		
	4 or more	1	1.7	0	0.0	0	0.0		
Mode of Delivery in Last Pregnancy	Vaginal delivery	30	45.5	19	32.7	35	28.8	5.440**	0.247*
	Cesarean	21	38.2	25	38.8	54	45.2		
	No delivery	9	16.4	16	28.6	31	26.0		

Table 1 (continued)

Variables		Right Lateral Side-Lying Position		Semi-Fowler Position		Left Lateral Side-Lying Position		Test Score	p
		n	%	n	%	n	%		
Position during previous CTG[1]	Left Lateral Side-Lying Position	43	74.5	40	67.3	86	79.6	13.668**	**0.006***
	Right Lateral Side-Lying Position	15	21.8	10	16.4	33	19.4		
	Semi-Fowler Position	2	3.6	10	16.4	1	1.0		

Cardiotocography, 2 $\bar{x}$: mean, SD: Standard deviation, [3] Body Mass Index

*$p<0.05$, $p<0.01$ **Chi-square test, Cardiotocography

Table 2 Comparison of CTG evaluation parameters according to CTG position

Variables	CTG Duration	Right Lateral Side-Lying Position (1)		Semi-Fowler Position (2)		Left Lateral Side-Lying Position (3)		Test Score	*p*	Bonferroni Group
		$\bar{X}^2$	SD[3]	$\bar{X}$	SD	$\bar{X}$	SD			
Starting time of CTG		11.76	2.14	11.30	1.87	11.76	2.13	0.991**	0.373*	
Ending time of CTG		13.86	13.83	11.61	1.84	12.09	2.14	1.635**	0.197*	
CTG Duration		20.24	1.99	18.46	2.82	20.25	3.07	8.919**	**0.000***	**2 > 1, 2 > 3**
Basal Heart Rate	In first 5 min	138.13	9.43	143.57	7.93	137.50	10.64	7.542**	**0.001***	**2 > 1, 2 > 3**
	6th-10th minutes	139.54	9.63	143.69	8.09	138.16	11.48	5.321**	**0.006**	**2 > 3**
	11th-15th minutes	140.18	9.82	143.87	8.88	139.36	10.70	3.769**	**0.025***	**2 > 3**
	16th-20th minutes	140.04	9.40	143.35	8.40	139.53	10.47	2.939**	0.055*	
Fetal tachycardia	In first 5 min	168.33	10.40	168.75	7.50	175.	5.00	0.700**	0.528*	
	6th-10th minutes	170.00	0.00	172.00	5.70	170.00	0.00	0.205**	0.820*	
	11th-15th minutes	168.00	0.00	170.00	5.4	172.00	4.87	1.409**	0.543*	
	16th-20th minutes	165.00	0.00	170.00	5.00	175.00	7.07	1.063**	0.448*	
Bradycardia	At 5th minute	-	-	-	-	-	-	-	-	
	6th-10th minutes	100.00	-	107.50	10.60	-	-	0.333	0.667*	
	11th-15th minutes	-	-	-	-	-	-	-	-	
	16th-20th minutes	-	-	-	-	-	-	-	-	
Fetal Movement	In first 5 min	4.80	4.07	3.72	2.34	7.48	5.22	15.980**	0.000*	**3 > 2, 3 > 1**
	6th-10th minutes	4.54	3.98	3.55	2.71	6.58	5.55	9.100**	0.000*	**3 > 2, 3 > 1**
	11th-15th minutes	4.49	3.72	3.05	2.46	6.49	4.87	13.829**	0.000*	**3 > 2, 3 > 1**
	16th-20th minutes	4.39	3.95	3.05	2.21	6.52	4.33	16.720**	0.000*	**3 > 2, 3 > 1**
Number of Contractions	In first 5 min	2.96	3.14	2.74	2.53	2.95	2.88	0.442***	0.802	
	6th-10th minutes	1.93	2.70	1.90	2.63	1.69	2.28	0.151***	0.927*	
	11th-15th minutes	1.09	0.396	0.98	0.23	1.12	0.376	5.835***	0.054*	
	16th-20th minutes	1.16	0.77	1.32	1.05	1.08	0.056	1.313***	0.519*	
Intensity of Contraction	In first 5 min	26.31	24.34	20.23	22.86	25.06	24.23	1.011***	0.603	
	6th-10th minutes	46.16	23.54	44.98	22.18	46.28	21.60	0.028***	0.986*	
	11th-15th minutes	46.16	23.54	44.98	22.18	46.28	23.54	0.028***	0.986*	
	16th-20th minutes	25.75	10.34	22.26	20.00	24.82	10.54	0.102	0.950*	
Accelerations	In first 5 min	1.08	1.03	1.61	1.05	1.11	0.96	5.318**	**0.006***	**2 > 1, 2 > 3**
	6th-10th minutes	1.18	1.08	1.51	1.11	1.18	1.08	2.015**	0.136*	
	11th-15th minutes	1.39	1.14	1.74	1.10	1.40	1.08	1.953**	0.144*	
	16th-20th minutes	1.32	1.22	1.70	1.50	1.45	1.12	1.347**	0.262*	
Decelerations	In first 5 min	0.06	0.24	0.11	0.46	0.18	0.55	1.895***	0.388*	
	6th-10th minutes	0.04	0.21	0.21	0.68	0.27	0.62	8.075**	0.018*	**1 > 3**
	11th-15th minutes	0.08	0.33	0.12	0.38	0.15	0.40	2.255***	0.324*	
	16th-20th minutes	0.04	0.21	0.07	0.26	0.18	0.50	4.439***	0.109*	

Cardiotocography, [2] $\bar{x}$: mean, [3] SD: Standard deviation

*$p<0.05$, $p<0.01$ ** ANOVA, ***Kruskal–Wallis test

in fetal movements during the CTG based on position maximum at 16–20 min ($p<0.05$), with the mean movement in the left lateral position (control group) being significantly different from that in the other positions. Decelerations during the CTG also exhibited statistically significant differences across various positions ($p<0.05$), with the right lateral position (Intervention 1) differing significantly from the left lateral position.

Table 3 presents the results of vital sign monitoring before, during, and after CTG, categorized by CTG position, revealing differences between the positions. Systolic blood pressure and body temperature were significantly different before, during, and after CTG in terms of position, time, and group-time results ($p<0.05$). These differences were predominantly driven by the significant variations associated with the semi-Fowler position compared with other positions. In terms of time, significant differences were observed at the time of CTG compared with other times. Diastolic blood pressure and pulse rates also demonstrated statistically significant differences in values recorded before, during, and after CTG in relation to position and time ($p<0.05$). Diastolic blood pressure measurements differed over time, with values before and after CTG significantly differing from those recorded at the time of CTG ($p<0.05$). Compared with the mean values at other positions, the right lateral position had a statistically significant difference in pulse rate. In terms of pulse rate, the values recorded before CTG were different from the values recorded at other times.

Table 4 provides an analysis of the impact of BMI on vital signs when CTG was performed in different positions. Systolic blood pressure (semi-fowler position: 107.08±8.15), diastolic blood pressure (semi-fowler position: 64.64±7.29), and body temperature (semi-fowler position: 36.24±0.14), were significantly different between the groups ($p<0.05$). However, BMI and BMI by position did not appear to affect vital signs ($p>0.05$).

The regression analysis results, presented in Table 5, indicate the significance level corresponding to the F value in the general comfort scale mean score across positions. Notably, only the semi-Fowler position exhibited statistical significance (F=17.366; $p<0.05$). The beta coefficient of the independent variable, the t value, and the significance level showed that the semi-Fowler position had a statistically significant effect on comfort (t=3.834, $p<0.05$). This result explained 5.8% of the change in general comfort (adjusted R2=0.058). Specifically, the semi-Fowler position led to a 0.911 increase in general comfort (β=0.911).

Discussion

The recommended maternal positions during cardiotocography (CTG) include left lateral, semi-Fowler, left lateral semi-Fowler, and sitting positions. These positions have been shown in previous studies to optimize uterine perfusion and fetal heart rate while preventing maternal hypotension [16–18].

In this study, a statistically significant relationship was found between CTG positions and sociodemographic characteristics, especially place of residence, number of miscarriages and previous CTG positions. The significant difference observed for the 'place of residence' variable in CTG position preferences may be interpreted as the potential influence of socio-cultural factors and regional health practices on these preferences. These relationships may result from differences in cultural norms and practices in different residential areas, the influence of previous obstetric experiences such as miscarriage on maternal comfort and preferences, and familiarity with certain CTG positions based on previous experience. The

Table 3 Intergroup comparisons of vital signs during CTG

		Right Lateral Side-Lying Position (1) X ± SD[2]	Semi-Fowler Position (2) X ± SD	Left Lateral Side-Lying Position (3) X ± SD	Test Score**	*p*	Bonferroni Group	Bonferroni Time
Blood Pressure (Systolic)	Before CTG (1)	113.67±10.06	108.16±10.56	112.80±11.21	F_{Group}=7.964	**0.000***	**2>3, 2>1**	**1>3, 1>2**
	At the moment of CTG (2)	110.37±9.41	107.00±8.57	108.89±11.00	F_{Time}= 13.014	**0.000***		
	After CTG (3)	115.91±10.76	100.08±8.15	113.56±12.28	$F_{GroupxTime}$= 2.649	**0.000***		
Blood Pressure (Diastolic)	Before CTG (1)	71.00±9.06	66.83±6.83	69.20±9.90	F_{Group}=6.829	**0.000***	**1>3, 1>2**	**2=3>1**
	At the moment of CTG (2)	67.00±9.60	64.29±7.26	66.56±11.70	F_{Time}= 9.940	**0.000***		
	After CTG (3)	70.41±10.18	64.64±7.29	71.10±11.36	$F_{GroupxTime}$= 2.049	0.090*		
Pulse	Before CTG (1)	94.70±10.84	97.77±11.03	93.37±12.28	F_{Group}=5.461	**0.005***	**2>1, 2>3**	**3>2, 2>1**
	At the moment of CTG (2)	92.24±10.60	95.88±10.51	89.84±11.29	F_{Time}= 10.315	**0.000***		
	After CTG (3)	92.06±10.53	96.20±9.31	91.77±10.23	$F_{GroupxTime}$= 0.822	0.512*		
Body Temperature	Before CTG (1)	36.32±0.46	36.29±0.15	36.49±0.49	F_{Group}=11.776	**0.000***	**3>2, 3>1**	**1>2>3**
	At the moment of CTG (2)	36.40±0.50	36.26±0.17	36.60±0.51	F_{Time}= 3.975	**0.023***		
	After CTG (3)	36.41±0.49	36.24±0.14	36.58±0.51	$F_{GroupxTime}$= 3.232	**0.015***		

Cardiotocography, [2] $\bar{x}$: mean SD: Standard deviation

$p<0.05$, $p<0.01$ **Kruskal–Wallis Hypothesis Test

Table 4 Comparison of the effects of body mass index on CTG position and vital signs

	Group		$\bar{X}^2$	SD[3]	F	*p*	Bonferroni
Systolic Blood Pressure	Right Lateral Side-Lying Position (1)		115.91	10.76	26.785**	**0.002***	**2 > 3, 1 > 3**
	Semi-Fowler Position (2)		107.08	8.15			
	Left Lateral Side-Lying Position (3)		113.56	12.28			
BMI					2.734**	0.157	
Group*BMI[4]					0.323**	0.862	
Diastolic Blood Pressure		Right Lateral Side-Lying Position (1)	70.41	10.18	14.054**	**0.010***	**2 > 3, 2 > 1**
		Semi-Fowler Position (2)	64.64	7.29			
		Left Lateral Side-Lying Position (3)	71.10	11.36			
BMI					2.193**	0.214	
Group*BMI					0.518**	0.722	
Pulse		Right Lateral Side-Lying Position (1)	92.06	10.53	6.002**	0.053	-
		Semi-Fowler Position (2)	96.20	9.31			
		Left Lateral Side-Lying Position (3)	91.77	10.23			
BMI					0.461**	0.658	
Group*BMI					0.733**	0.570	
Body Temperature		Right Lateral Side-Lying Position (1)	36.41	0.49	88.070**	**0.000***	**2 > 3**
		Semi-Fowler Position (2)	36.24	0.14			
		Left Lateral Side-Lying Position (3)	36.58	0.51			
BMI					3.572**	0.072	
Group*BMI					0.076**	0.989	

Cardiotocography, [2] $\bar{x}$: mean, [3] SD: Standard deviation

*$p<0.05$, $p<0.01$** ANOVA, [1]BMI: Body mass index

Table 5 Effect of the CTG position on the general comfort questionnaire score

Dependent Variable	Independent Variable	β	Standard Error	Beta	t	*p*	F**	Model (*p*)	R2
General Comfort Questionnaire Score	(Constant)	3.398	0.168	-	20.168	**0.000***	3.034	0.083	0.012
	Right Lateral Side-Lying Position	−0.163	0.094	−0.112	-1.742	0.083			
	(Constant)	2.506	0.163	-	15.335	**0.000***			
	Semi-Fowler Position	0.349	0.911	0.240	3.834	**0.000***	14.700	**0.000***	0.058
	(Constant)	3.329	0.129	-	25.786	**0.000***	3.090	0.080	0.013
	Left Lateral Side-Lying Position	-0.143	0.081	-0.113	-1.758	0.080			

Cardiotocography

CTG process taking less than 20 min

*$p<0.05$, $p<0.01$ ** Simple linear regression

statistical difference observed in the variable 'Position during previous CTG' underscores the importance of prior experiences in shaping maternal preferences, suggesting that familiarity and comfort with previously used positions may influence current choices, which has implications for personalized care and improving maternal satisfaction during CTG monitoring.

In our study, we found that the semi-Fowler position (Intervention 2) led to a shorter CTG duration, optimized basal heart rate, and increased number of accelerations, resulting in significant differences between groups ($p<0.05$). Another randomized controlled trial reported that the semi-Fowler position was effective in achieving a faster CTG result than the left lateral position [1]. Considering the high number of pregnant women seeking antenatal care from perinatal nurses and midwives, the utilization of the semi-Fowler position may expedite CTG results.

Our study revealed that the left lateral position (control group) during CTG led to an increase in the number of fetal movements and caused significant differences between groups ($p<0.05$). However, the presence of decelerations in the CTG was more pronounced in the right lateral position (Intervention 1). These findings contrast with some studies that reported no significant difference in the basal heart rate related to different maternal positions during CTG [4]. Other studies reported increased CTG reactivity in the left lateral semi-Fowler position but not significantly different from that in the semi-Fowler or left lateral positions [1]. Kaur et al. [19] reported no significant difference between the left lateral and sitting positions in terms of CTG reactivity.

Our study, similar to the results of Ibrahim et al. [18], indicated that the semi-Fowler position led to higher fetal heart rates than the supine and left lateral positions did. A study examining the position and fetal health in pregnancies between 36 and 40 weeks found that umbilical artery flow increased when transitioning from the left lateral to the supine position ($p<0.001$), indicating that vascular resistance in the umbilical-placental circulation increases in the supine position, opposing forward flow [20]. This variation in findings underscores the need for further exploration of maternal positions during CTG.

With respect to maternal vital signs, our study revealed that the semi-Fowler position exhibited significant differences in maternal blood pressure and body temperature during CTG. Additionally, the right lateral position was associated with an increase in the maternal pulse rate [21]. Unlike other studies, our research indicated that not only maternal blood pressure but also parameters such as body temperature and pulse rate were affected by maternal position during CTG. Although statistical significance was obtained for body temperature and pulse rate were affected by maternal position during, this difference is not clinically relevant. This difference was thought to be more of a reflection of maternal comfort. Previous studies reported that maternal blood pressure was within normal limits in all three positions, but the respiratory rate increased in the left lateral and semi-Fowler positions [17, 22]. In contrast, maternal hypotension was noted in the supine position in other studies, which was attributed to pressure on the inferior vena cava [23, 24]. Our findings suggest that the right lateral position could be considered an alternative to the supine position.

Our study also highlighted the impact of BMI on maternal systolic blood pressure, diastolic blood pressure, and body temperature at different CTG positions. Previous studies have rarely explored the relationship between maternal position and fetal monitoring with respect to BMI. Our data suggest that pregnant women with a high BMI may benefit from the semi-Fowler position during fetal monitoring. In a randomized controlled trial evaluating external fetal electrocardiogram monitoring systems, wireless CTG application resulted in more interpretable data in subjects with a body mass index (BMI) ≥ 30 kg/m^2 [25]. It was suggested that, alongside the position, the device used during CTG could also have an impact.

Finally, when examining the relationship between maternal comfort and position during fetal monitoring, our study revealed that the semi-Fowler position provided the highest level of comfort. Maternal comfort is known to influence the accuracy of fetal monitoring results [1, 17, 22, 26, 27]. However, some studies reported that the left lateral position contributed more to comfort than the semi-Fowler and supine positions did [19]. The present study suggests that the semi-Fowler position can be a comfortable alternative to the left lateral position for pregnant women.

Limitations of this study

This study has several limitations that should be considered when the findings are interpreted. First, the research was conducted in a single healthcare facility, which may restrict the generalizability of the results to other settings or populations. Second, only maternal comfort and fetal well-being during a 20-minute session of electronic fetal monitoring were assessed, and long-term outcomes were not evaluated. In addition, the Intervention group experienced a drop-out rate of approximately 20 per cent. This was due to the CTG process taking less than 20 min and incomplete data entry. Future research should address these limitations by employing multicenter designs, extending monitoring durations, and considering additional maternal and fetal factors.

Conclusions

In conclusion, this study provides important insights into the effects of maternal positioning during antenatal electronic fetal monitoring. Compared with other positions, the semi-Fowler position was associated with higher baseline fetal heart rates, increased fetal movements, and greater fetal accelerations. These findings suggest that maternal position can significantly influence fetal heart rate patterns. Additionally, maternal blood pressure exhibited notable differences in the semi-Fowler position during repeated measurements, highlighting the potential impact of this position on maternal cardiovascular status, which is of particular relevance to perinatal nursing and midwifery practice.

Furthermore, the right lateral position was associated with an increase in maternal heart rate, emphasizing the importance of monitoring maternal hemodynamics during fetal monitoring in this position. Compared with other positions, the semi-Fowler position also appeared to offer greater maternal comfort, whereas the left lateral position emerged as a suitable alternative, promoting maternal well-being. Notably, pregnant women with higher BMIs may benefit from the semi-Fowler position during fetal monitoring, a finding that underscores its practical implications in perinatal care.

The findings of this study highlight the critical importance of selecting an appropriate maternal position during cardiotocography to ensure accurate assessment and to optimize both maternal and fetal outcomes. The development of standardized protocols for antenatal electronic fetal monitoring is essential to guide clinical practice, as incorrect positioning may lead to inaccurate results. Therefore, implementing such guidelines is crucial for enhancing the quality of care in perinatal settings.

Abbreviations

CTG	Cardiotocography
BMI	Body mass index
GCQ-SF	General Comfort Questionnaire-Short Form confidence interval (CI)
EFM	Electronic fetal monitoring
ACOG	American College of Obstetricians and Gynecologists
FHR	Fetal Heart Rate
NST	Nonstress test
FIGO	The International Federation of Gynecology and Obstetrics

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Author contributions
T.Y.E. designed the study, conducted literature searches and provided summaries of previous research studies. A.D.Y. conducted the statistical analysis. T.Y.E., A.D.Y and E.S. wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

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Data availability
The datasets analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethics committee approval was obtained from the Ethics Committee of Istanbul Zeynep Kamil Women's and Children's Diseases Training and Research Hospital where this research was conducted. (Decision No. 123; Date: 18.12.2019). Written permission for the use of the scale was obtained. Written informed consent was obtained from the study participants. The participants entered the study on a voluntary basis.

Consent for publication
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Competing interests
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