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## The effect of yoga on uterine artery Doppler indices, maternal and fetal complications in pregnant women: A quasi-experimental study

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## ABSTRACT

**Background:** Today, the effect of yoga has been examined on various physical and psychological dimensions of pregnant women. However, there are still sparse studies on the effect of yoga on the uterine artery indices as well as maternal and fetal complications.**Objective:** The aim was to determine the effect of yoga on uterine artery Doppler indices, maternal and fetal Complications.**Materials and methods:** This quasi-experiential study was conducted, on 100 pregnant women. The participants were assigned to yoga and control groups. In the yoga group, the participants exercised yoga for 1 h. On the other hand, the control group received routine care.**Results:** The results showed that in the yoga group, the functional indices of the uterine artery (S/D, PI, RI, and DN) improved more significantly compared to the control ( $p = 0.01$ ). The results also showed that in the yoga group, maternal complications (diabetes and preeclampsia), as well as fetal complications (SAG, IUGR), were significantly lower compared to the control ( $p = 0.01$ ).**Conclusion:** This study revealed the positive effects of yoga on improving fetal development indices and reducing maternal and fetal complications following pregnancy. It can be used as a Complementary therapy alongside other treatments for mothers.© 2020 The Authors. Published by Elsevier B.V. on behalf of Institute of Transdisciplinary Health Sciences and Technology and World Ayurveda Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Background

The prenatal period is the most important for the development of a healthy neonate [1]. During this period, mothers undergo various physical and psychological changes, which can have irreversible effects on both the mother and fetus [2]. In the physical dimension, studies have shown that improved uterine perfusion prevents various complications such as preeclampsia [3,4], premature birth [5,6], intrauterine growth restriction [7,8], and small fetus for gestational age [9,10]. The measures that improve mothers' health during pregnancy can ameliorate uterine perfusion and reduce both maternal and

fetal complications [11,12]. Yoga is considered one of the oldest alternative medicine interventions [13–15]. Studies have shown that yoga has positive effects on gestational depression [16], stress [17], increased comfort [18], increased fetal weight [19], quality of life [20], faster and easier delivery [19], and labor pain [21]. Studies have also indicated that the fetus of athlete women better tolerates the labor process than the fetus of non-athlete women [22,23]. It is also reported regular physical activity can prevent the incidence of preeclampsia through three key processes: 1. Increasing placental development and vascularity, 2. Reducing oxidative stress, and 3. Improving endothelial function disorders [24–26]. Despite various studies on the physical and psychological dimensions of pregnant mothers, fewer studies have been done on the effect of yoga on improving uterine artery function. This study was performed to examine the effect of yoga on uterine artery Doppler indices, maternal, and fetal complications.

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## 2. Materials and methods

### 2.1. Design and participants

This quasi-experimental study was conducted on 100 pregnant women referring to the prenatal clinic in Zabol City, southeast of Iran, from 20 January 2019 to 1 September 2019. The pregnant women who were in the weeks 18–20 of gestation were chosen through convenience sampling methods. The inclusion criteria were: normal pregnancy, complete health of the mother, age 20–40 years, no history of gestational diabetes, preeclampsia, premature delivery, fetal death, intrauterine growth restriction, and small fetus for gestational age during previous deliveries. The exclusion criteria were no willingness to participate in the study, lack of access to the patient, patient's death, high-risk pregnancy, use of drugs.

### 2.2. Intervention

After receiving permission from the research deputy, the researchers visited the clinic and explained the study objectives to the potential participants. To determine the sample size at 95% confidence level and test power of 80%, by knowing the mean and standard deviation after the intervention in both case and control groups as 16.88, 12.92, 6.06, and 6.09, the size was obtained as 50 in each group. Then, 110 participants available were examined in terms of inclusion criteria.

Ten subjects quit the study due to unwillingness, and thus 100 subjects were assigned in the intervention (yoga) ( $n = 50$ ) and control (routine care) ( $n = 50$ ). Before the intervention, first uterine artery Doppler sonography was done on all participants, where the right and left uterine artery function indices as well as those of the fetal artery were recorded. Next, the patients were randomly assigned to yoga and control groups. In the yoga group, the participants practiced yoga was performed three days a week for 60 min for 10 weeks between 20 and 30 weeks of pregnancy. Yoga

was performed in a quiet room near the prenatal clinic. Yoga intervention was designed with the help of a yoga specialist with 10 years of experience and a midwife with 8 years of experience specifically for mothers in second and third trimesters. In each part of the intervention, participants were guided by an expert on how to do it right. Participants at each stage of yoga could quit the exercise if they were upset or bleeding. Each session includes physical postures (10 min), deep breathing techniques (15 min), deep relaxation (10), and meditation (20 min).

At week 30 of gestation, they again underwent sonography to test the uterine artery function indices, which were recorded by the researcher. In the control group, the participants received routine care of pregnancy. After week 30 of gestation, the sonography findings were compared between the two groups. All participants were present from the first stage of intervention to the end of the study (Fig. 1).

### 2.3. Instrument

The information was collected through a questionnaire. The collected data included demographic characteristics (age of mothers (age), the fetus (weight, femur length, fetal heart rate, head circumference, biparietal diameter (BPD)), right and left uterine artery function plus fetal indices (Systolic/diastolic ratio (S/D), Pulsatility index (PI), resistance index (RI), Diastolic notch (DN)), resistance index (RI), diastolic groove) as well as maternal (diabetes and preeclampsia) and fetal (SAG, IUGR) complications. Gestational diabetes was assessed using the OGTT test. Preeclampsia was defined as the presence of (1) a systolic blood pressure (SBP) greater than or equal to 140 mm Hg or diastolic blood pressure (DBP) greater than or equal to 90 mm Hg or higher, on two occasions at least 4 h apart in a previously normotensive patient, OR (2) an SBP greater than or equal to 160 mm Hg or a DBP greater than or equal to 110 mm Hg or higher (In this case, hypertension can be confirmed within minutes to facilitate timely antihypertensive therapy)" [26].

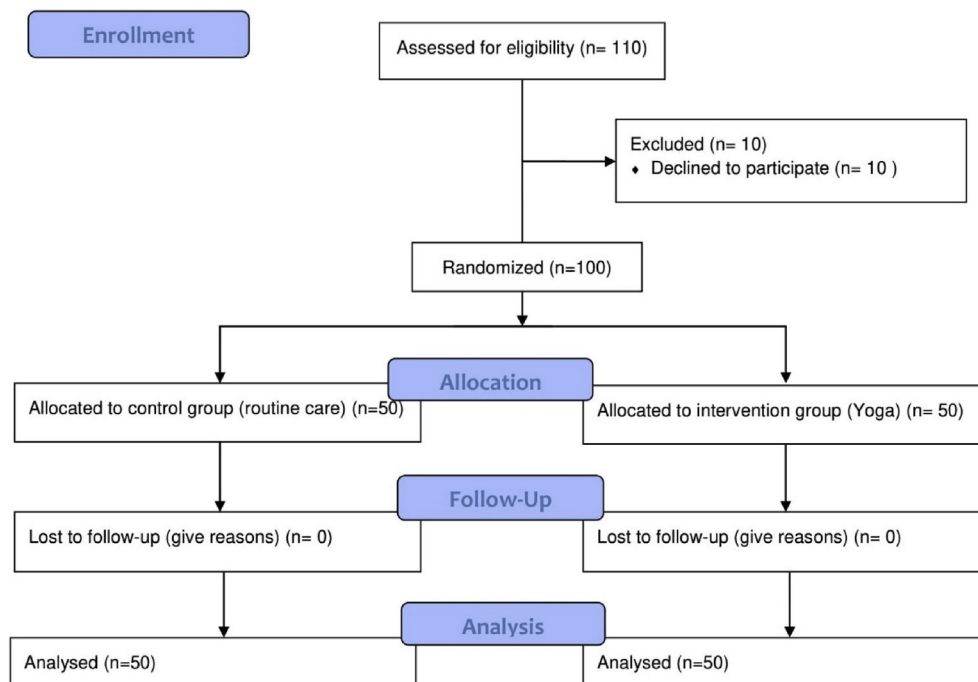


Fig. 1. Study flow diagram.

**Table 1**  
Comparison of the basic biometric parameters of fetal between the yoga and control groups in 20 and 30 weeks of pregnancy.

Variable		Groups		P-value
		Intervention group (yoga) Mean $\pm$ SD	Control group (routine care) Mean $\pm$ SD	
Biparietal diameter (BPD) (centimeter)	W20	2.67 $\pm$ 28.47	47.16 $\pm$ 3.87	0.857
	W30	$\pm$ 18.76 3.24	87/2 $\pm$ 00/73	0.001
Head circumference (HC) (centimeter)	W20	173.68 $\pm$ 3.50	173.02 $\pm$ 4.24	0.398
	W30	265.46 $\pm$ 12.96	256.06 $\pm$ 9.40	0.001
Femur length (FL) (centimeter)	W20	30.78 $\pm$ 2.83	29.80 $\pm$ 3.76	0.144
	W30	54.80 $\pm$ 3.81	51.62 $\pm$ 3.68	0.001
Heart rate (HR) (Bpm)	W20	152.44 $\pm$ 10.18	154.56 $\pm$ 11.74	0.337
	W30	139.50 $\pm$ 5.17	135.14 $\pm$ 5.07	0.001
Estimated fetal weight (EFW) (gram)	W20	0.36 $\pm$ 0.004	0.36 $\pm$ 0.002	0.821
	W30	1.24 $\pm$ 0.037	1.16 $\pm$ 0.033	0.001

#### 2.4. Ethical consideration

This study was approved by the Ethics Committee of Zabol University of Medical Sciences and the Ethics Committee of the place where the research was conducted (Ethic code: IR.ZB-MU.REC.1398.191). The JBI checklist for quasi-experimental studies was used to report the study [27].

#### 2.5. Data analysis

Descriptive (mean, standard deviation, frequency, and percentage) and analytical (chi-square, Independent t-test) tests were used for data analysis. Chi-square was used to examine the effect of yoga on maternal (diabetes and preeclampsia) and fetal (SAG, IUGR) complications. An Independent t-test was applied to determine the impact of yoga on fetal indices in both yoga and control groups. SPSS Version 20.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to analyze the data. The confidence interval of 95% and a significance level of P-value less than 0.05 was considered significant.

### 3. Results

The mean age of the mothers in the yoga group was  $26.74 \pm 6.85$  and in the control was  $24.52 \pm 4.94$  years. There are basic biometric parameters used to assess fetal size. The parameters are included: Biparietal diameter, Head circumference, Femur length, estimated fetal weight, and Heart rate. Regarding the basic biometric parameters of the fetus in the yoga and control groups at weeks 20 and 30 of gestations, it was found that yoga improved various fetal

indices (BPD, HC, FL, HR, EFW) at the end of the week 30 of gestation (Table 1).

The results show that yoga leads to improvement in right and left uterine artery function parameters (Systolic/diastolic ratio (S/D), Pulsatility index (PI), resistance index (RI), and Diastolic notch (DN)) (Table 2).

The study also found that yoga leads to improved fetal-placental perfusion function indices (Table 3).

#### 3.1. The effect of yoga on maternal and fetal complications

Regarding the maternal complications which were developed during the study, the results showed that the prevalence of preeclampsia ( $p = 0.04$ ) and diabetes ( $p = 0.01$ ) was significantly lower in the yoga group than in the control; the prevalence of diabetes in the yoga group was 4%, while it was 16% in the control group. Also, regarding preeclampsia, the prevalence in the yoga group was 2% and in the control group 14%. Further, in the present study, 2% of those who practiced yoga and 16% of women who did not practice it had intrauterine growth restriction. Performing yoga caused a significant reduction in IUGR of the fetus in this study (Table 4).

### 4. Discussion

Today, yoga is of interest as a popular field of alternative medicine. This semi-experimental study was done to examine the impact of yoga on uterine artery function, as well as maternal and fetal complications. The results showed that yoga caused a

**Table 2**  
The effect of yoga on right and left uterine artery parameters.

Uterine artery	uterine artery indices	Weeks	Groups		P-value
			Intervention group (yoga) Mean $\pm$ SD	Control group (routine care) Mean $\pm$ SD	
Right uterine artery	Systolic/diastolic ratio (S/D)	W20	33.2 $\pm$ 0.18	2.38 $\pm$ 0.21	0.171
		W30	2.02 $\pm$ 0.18	1.96 $\pm$ 0.19	0.094
	Pulsatility index (PI)	W20	0.84 $\pm$ 0.17	0.88 $\pm$ 0.18	0.277
		W30	0.72 $\pm$ 0.22	1.01 $\pm$ 0.19	0.001
	Resistance index (RI)	W20	0.51 $\pm$ 0.01	0.51 $\pm$ 0.023	0.576
		W30	0.47 $\pm$ 0.026	0.54 $\pm$ 0.036	0.001
Diastolic notch (DN)	W20	2 (4%)	3 (6%)	0.646	
	W30	1 (2%)	1 (2%)	0.812	
Left uterine artery	Systolic/diastolic ratio (S/D)	W20	1.97 $\pm$ 0.25	2.03 $\pm$ 0.27	0.264
		W30	1.83 $\pm$ 0.16	1.86 $\pm$ 0.16	0.471
	Pulsatility index (PI)	W20	0.86 $\pm$ 0.17	0.90 $\pm$ 0.332	0.448
		W30	0.74 $\pm$ 0.25	0.79 $\pm$ 0.16	0.267
	Resistance index (RI)	W20	0.52 $\pm$ 0.02	0.53 $\pm$ 0.06	0.223
		W30	0.46 $\pm$ 0.03	0.47 $\pm$ 0.02	0.077
Diastolic notch (DN)	W20	1 (2%)	4 (8%)	0.169	
	W30	1 (2%)	3 (6%)	0.307	

**Table 3**  
The effect of yoga on the fetal-placental circulation indices.

Artery	Artery indices	Week of pregnancy	Groups		P-value
			Intervention group (yoga) Mean $\pm$ SD	Intervention group (yoga) Mean $\pm$ SD	
Placental artery	Systolic/diastolic ratio (S/D)	W20	2.63 $\pm$ 0.16	2.68 $\pm$ 0.17	0.200
		W30	2.71 $\pm$ 0.25	2.98 $\pm$ 0.19	0.094
	Pulsatility index (PI)	W20	1.06 $\pm$ 0.108	1.03 $\pm$ 0.11	0.253
		W30	0.90 $\pm$ 0.09	1.02 $\pm$ 0.09	0.003
	Resistance index (RI)	W20	0.63 $\pm$ 0.024	0.63 $\pm$ 0.028	0.970
		W30	0.61 $\pm$ 0.026	0.69 $\pm$ 0.04	0.001
Fetal middle cerebral artery	Systolic/diastolic ratio (S/D)	W20	5.008 $\pm$ 0.09	5.04 $\pm$ 0.09	0.051
		W30	4.93 $\pm$ 0.09	6.34 $\pm$ 0.34	0.001
	Pulsatility index (PI)	W20	1.95 $\pm$ 0.107	1.95 $\pm$ 0.108	0.782
		W30	1.74 $\pm$ 0.087	2.29 $\pm$ 0.20	0.001
	Resistance index (RI)	W20	0.76 $\pm$ 0.05	0.77 $\pm$ 0.05	0.243
		W30	0.79 $\pm$ 0.03	0.87 $\pm$ 0.04	0.001

**Table 4**  
Effect of yoga on maternal and fetal complications.

Type of complications	Outcome	Studied group	Developing gestational diabetes		Value p*
			No (%)	Yes (%)	
Maternal	Diabetes	yoga	48 (96)	2 (4)	04/0
		control	42 (84)	8 (16)	
	Preeclampsia	yoga	49 (98)	1 (2)	01/0
		control	43 (86)	7 (14)	
Fetal	IUGR	yoga	49 (98)	1 (2)	01/0
		control	42 (84)	8 (16)	
	SAG	yoga	47 (94)	3 (6)	03/0
		control	40 (80)	10 (20)	

significant improvement in the right uterine artery indices including resistance index (RI), Pulsatility index (PI), and systolic/diastolic ratio (S/D), but it had no significant effect on the left uterine artery. The RI has been defined as a measurement scale for pulsating blood circulation, demonstrating the resistance against blood flow resulting from the farthest point of vascular bed [28,29]. RI of 0 shows a constant flow. However, RI close to 1 indicates systolic contraction alone. One the other hand, RI greater than 1 has an inverse relationship with diastolic circulation. Pulsatility index (PI) measures the changes in the blood velocity in one vessel, which is equal to the difference between peak systolic and maximum diastolic velocity divided by the average velocity along the cardiac cycle [30]. Meanwhile, the systolic/diastolic ratio (S/D) is a simple ratio of these two. High impedance has been shown in uterine arteries at 20–28 weeks of gestation, revealing more than 80% of the probability of developing premature onset of preeclampsia [31]. There is also a relationship between RI and fetal growth at gestational age [32]. Accordingly, RI in this study was followed-up closely. The results here also showed that RI was significantly better in the case group than in control in the umbilical artery in fetal MCA following 10 weeks of intervention (measured at week 30).

The results of the present study were in line with those of previous studies, suggesting the impact of yoga on improving functional indices of uterine artery and fetal indices [33]. The results also showed that in the yoga group, compared to the control, significantly fewer maternal (diabetes and preeclampsia) and fetal (SAG, IUGR) complications were observed compared to the control, which is in line with the studies by Rakhshani et al. and Narendran S et al. [34,35]. Yoga, given its ability to reducing blood pressure and stress, enjoys special popularity [36,37]. This is important since pharmacological solutions have shown limited effectiveness in reducing uterine artery resistance against blood flow due to the complications caused by gestational hypertension [38]. Pregnancy

per se is a stressful period in any woman's life, and the results suggest that women during this period of their life experience great pressure to their cardiovascular system [39]. Nevertheless, studies largely indicate that yoga reduces stress in pregnant women [39]. Thus, maybe yoga interventions in this study would have a positive impact on maternal stress, causing diminished sympathetic tone, which in turn relaxes the uterine arteries, resulting in better blood circulation. Yoga also causes a reduction of blood pressure, which in turn leads to diminished oxidative stress in patients with hypertension [40]. This can lead to better trophoblast perfusion and less resistance in uterine arteries. This study had some limitations. First, the number of available samples for the study was low, which may have affected the validity of data. Although it was attempted that participants would not use drugs during the study, some of them may have consumed multivitamins, which again might have affected the study results.

## 5. Conclusion

The present study indicated that yoga in addition to a positive impact on the fetal development parameters was able to significantly improve the perfusion of placental and fetal arteries. It also had positive effects on maternal and fetal outcomes. Considering the study limitations, studies with a larger sample size should be performed.

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## Conflict of interest

None.

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