Research Article

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Nepal Journal of Health Sciences

Comparative Ultrasonographic Assessment of Splenic Length in Non-Pregnant and Pregnant Women

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Artical Info

Article History:

Recived date: Jan 1, 2026
Revised date: Feb 20, 2026
Accepted date: Apr 1, 2026
Published date: May 15, 2026

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Online Access:

DOI: 10.3126/njhs.v5i2.89264

Abstract

Introduction: The spleen is the largest organ of the reticuloendothelial and lymphatic systems and plays a crucial role in immune function and blood filtration. During pregnancy, increased blood volume and altered hemodynamics represent normal physiological changes that lead to an increase in spleen size. However, limited data are available regarding trimester wise changes.

Objective: To compare ultrasonographic assessment of splenic length in non-pregnant and pregnant women.

Methods: This comparative cross-sectional descriptive study was conducted in the Department of Radiology at Birat Medical College and Teaching Hospital, over a two-month period. About 200 healthy women were included, comprising 150 pregnant women (50 in each trimester) and 50 age and height matched non-pregnant controls. Splenic length was measured using a 3.5 MHz curvilinear transducer, with participants positioned supine or in the right lateral decubitus position as required. Descriptive and comparative analysis were performed using SPSS version 24.

Results: This study showed the mean splenic length in non-pregnant women as 96.60 ± 7.40 mm whereas 94.20 ± 7.60 mm, 99.0 ± 7.50 mm, and 106.20 ± 7.80 mm for pregnant women of 1st, 2nd and 3rd trimesters. Statistically significant increment in splenic length in women were noted, comparing control with 3rd trimester ($p < 0.001$), 1st with 2nd trimesters ($p=0.01$), 1st with 3rd trimesters ($p < 0.001$), and 2nd with 3rd trimesters ($p < 0.001$). There was non-significant difference observed comparing control with 1st ($p=0.39$) and 2nd ($p=0.39$) trimester of pregnancy.

Conclusion: Splenic length increases progressively with advancing gestation, especially in the second and third trimesters, reflecting normal physiological adaptations of pregnancy rather than pathology.

Keywords: Pregnancy; splenic length; ultrasound.

How to cite (Vancouver Style)

Yadav SK, Yadav R, Yadav A, Karn A. Comparative Ultrasonographic Assessment of Splenic Length in Non-Pregnant and Pregnant Women. Nepal J Health Sci. 2025;5(2):24-29.

Introduction

The spleen is an organ present in nearly all vertebrate species. It is considered the largest mobile reticuloendothelial system organ, situated intraperitoneally located in the superolateral region of the left upper quadrant of the abdomen.[1] This lymphatic organ is part of both the reticuloendothelial and lymphatic systems, playing a vital role in the body's immune responses and acting primarily as a blood filter.[2] The size of the spleen varies, approximately 7 to 14 cm in length.[3] During pregnancy, the spleen has more workload or increased demand for immune responses against microorganisms among other functions. Some researchers have reported that maternal blood volume could depend on the splenic size and pregnancy hormones.[4] Thus pregnancy has been identified as a contributing factor to splenomegaly. One of the primary reasons for this is the significant increase in maternal blood volume, cardiac output, production of erythrocytes and plasma in the bone marrow and increased clotting factor contributes to a significant rise in maternal blood volume.[5]

Evaluation of splenic size plays a crucial role in the diagnosis and management of various medical condition, including liver disease, immune disorders and hematological malignancies.[6] Thus, the objective of our study was to assess and compare spleen size in non-pregnant women and in pregnant women across all three trimesters.

Methods

This comparative analytical study aimed to evaluate splenic dimensions in healthy pregnant women and non-pregnant healthy individuals attending the Radiology department at Birat Medical College and Teaching Hospital from 20th October to 19th December 2025. The study was conducted over a period of two months. The sample size was determined using the two-sample comparison formula: $n=2(Z\alpha/2+Z\beta)2\ \sigma2)/\Delta2$ where, $Z\alpha/2$ = Z-value for 95% confidence (two-tailed) =1.96, $Z\beta$ = Z-value for 80% power = 0.84, σ = Standard deviation (from pilot data, sample size= 146 individuals) = 8.55 mm (from non-pregnant group), Δ = Minimum detectable difference in mean spleen length = typically 5 mm difference (clinically meaningful threshold).[7,8] Therefore, n=46 participants per group. For potential dropouts (an approximate 8% dropout adjustment), final adjusted sample size = 50 per group. This two-sample formula appropriate for primary pairwise comparisons may underestimate requirements for a four-group ANOVA. Therefore, ANOVA sample size was recalculated using stats models assuming a conservative Cohen's f ≈ 0.253 for detecting a 5 mm difference in one group while others remain equal. This resulted a total n ≈ 174 (≈44 per group) for 80% power at α=0.05. This aligned with the original calculation, supporting the use of n=50 per group post-adjustment.[8]

One hundred and fifty pregnant women were recruited having 50 participants in each trimester, along-side an equal number (50 control) of age and height matched non-pregnant women, resulting in a total sample size of 200 participants after obtaining written informed consent. Age and height was matched to reduce potential confounding factor. Demographic data; age, height and gestational period were systematically collected via structured questionnaires for all the participants as applicable. Ultrasound examinations were performed using a SONACE X4 ultrasound system (Medison Inc., Korea, 2009) equipped with a 3.5 MHz curvilinear transducer. Subjects were positioned supine on the examination couch with the head supported by a pillow for comfort. In cases of advanced pregnancy, the right lateral decubitus position (left side elevated) was utilized to optimize visualization. The abdomen was exposed from the xiphisternum extending down to the pubic symphysis. Scans were recorded during deep inspiration with a relaxed anterior abdominal wall to ensure consistent measurements which was performed by expert radiologist. Splenic length (SL) was measured longitudinally through the splenic hilum, spanning from the superior dome to the inferior tip. Participants were randomly selected based on the following inclusion criteria: women with confirmed singleton pregnancies between 8 and 38 weeks of gestation and age matched non-pregnant women as a control. Exclusion criteria included the history of febrile illness during the current pregnancy, malaria, portal hypertension, kala-azar, hemoglobinopathies such as sickle cell disease, previous splenectomy, or multiple gestations.

Ethical approval was granted by the institutional review committee of Birat Medical College and Teaching Hospital (Ref. 29-2082/83). All demographic and ultrasound data were entered into excel and imported to SPSS software version 24 for statistical analysis. One-way ANOVA Test was applied for comparing mean splenic length across four groups (non-pregnant and 3 trimesters). It was followed with Tukey's HSD post-hoc test for pairwise comparisons (adjusted p-values).

Results

This study was a descriptive statistical analysis of splenic length which was conducted among age and height matched non-pregnant and pregnant women attending Radiology department of BMCTH. Age (p=0.93) and height (p=0.95) of the non-pregnant and pregnant women of different trimester were comparable (Table 1). No statistically significant difference in age or height was observed among these groups.

Table 1: Comparing demographic variables of non-pregnant and pregnant women (n=200).

Variable	Non-Pregnant (n=50, mean ±SD)	1st T. (n=50, mean ±SD)	2nd T. (n=50, mean ±SD)	3rd T. (n=50, mean ±SD)	Test Statistic	p-value
Age (years)	29.0 ± 7.8	28.5 ± 7.5	29.2 ± 8.0	28.8 ± 7.6	F=0.15 (ANOVA)	0.93
Height (cm)	160.0 ± 5.0	159.5 ± 4.8	160.2 ± 5.1	159.8 ± 4.9	F=0.12 (ANOVA)	0.95
T=Trimester, cm=centimeter						

Table 2: Descriptive statistics and 95% confidence intervals for splenic length of non-pregnant and pregnant women (n=200).

Group	N (no. of sample)	Mean (mm)	SD (mm)	95% CI (mm)
Non-Pregnant	50	96.6	7.4	94.5 - 98.7
1st T.	50	94.2	7.6	92.0 - 96.4
2ndT.	50	99.0	7.5	96.9 - 101.1
3rd T.	50	106.2	7.8	104.0 - 108.4
T=Trimester, mm=millimeter.				

Observed splenic length at 95% CI ranged 94.5 - 98.7 mm (mean ± SD: 96.6 ± 7.4 mm) in non-pregnant healthy women, whereas it ranged 92.0 - 96.4 mm (mean ± SD: 94.2 ± 7.6 mm) in first trimester of pregnancy, 96.9 - 101.1 mm (mean ± SD: 99.00 ± 7.5 mm) in second trimester of pregnancy, and 104.0 - 108.4 mm (mean ± SD: 106.2 ± 7.8 mm) in third trimester of pregnancy (Table 2).

Significant differences in splenic length were observed between non-pregnant women and 3rd trimester women, 1st trimester women and 2nd trimester women, 1st trimester women and 3rd trimester women, and 2nd trimester women and 3rd trimester women. No significant differences were observed between non-pregnant women and 1st trimester women or non-pregnant women and 2nd trimester women. The 3rd trimester group had notably higher means compared to the others.(Table 3)

Table 3: Comparative analysis using Tukey HSD Post-Hoc test of splenic length between non-pregnant and pregnant women (n=200).

Group Pair	Mean Difference (mm)	95% Simultaneous CI (mm)	Adjusted p-value	Cohen's d (effect size)
Non-Pregnant vs. 1st T.	2.4	-1.53 to 6.33	0.390	0.32 (small)
Non-Pregnant vs. 2nd T.	-2.4	-6.33 to 1.53	0.390	0.32 (small)
Non-Pregnant vs. 3rd T.	-9.6	-13.53 to -5.67	<0.001	1.26 (large)
1st T. vs. 2nd T.	-4.8	-8.73 to -0.87	0.010	0.64 (medium)
1st T. vs. 3rd T. -12.0 -15.93 to -8.07 <0.001 1.56 (large)				
2nd T. vs. 3rd T.	-7.2	-11.13 to -3.27	<0.001	0.94 (large)
T=Trimester, mm=millimeter				

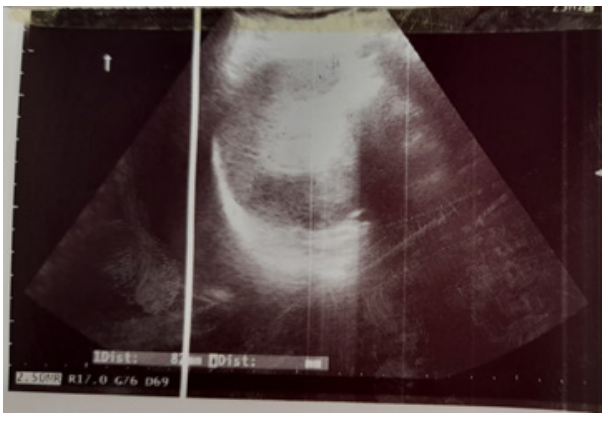

Figure 1a: Spleen size of non-pregnant control

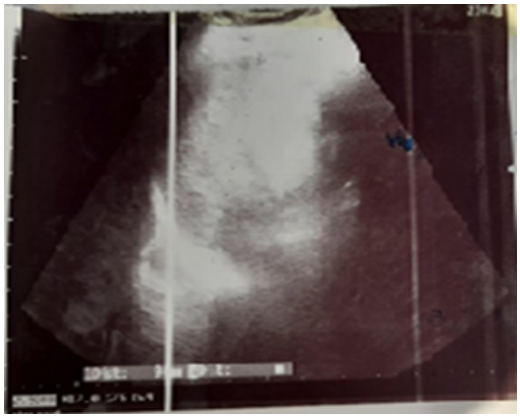

Figure 1b: Spleen size of 1st trimester pregnant women

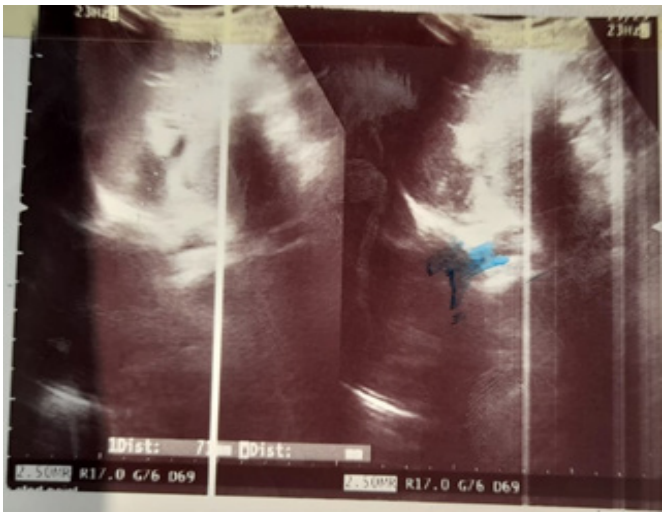

Figure 2a: Spleen size of 2nd trimester pregnant women

Figure 2b: Spleen size of 3rd trimester pregnant women

Discussions

This analytical study was conducted among age and height matched non-pregnant and pregnant women attending Radiology department of BMCTH having comparable age and height. The analysis of splenic length in present study documented 94.50 mm to 98.70 mm, with a mean value of 96.60 ± 7.40 mm in non-pregnant healthy women. The splenic length for pregnant women were reported as 92.00–96.40 mm (mean ± SD: 94.20 ± 7.60 mm) in first trimester of pregnancy, 96.90-101.10 mm (mean ± SD: 99.00 ± 7.50 mm) in the second trimester of pregnancy, and 104.00- 108.40 mm (mean ± SD: 106.20 ± 7.80 mm) in the third trimester of pregnancy. There was significant difference observed while comparing splenic length between non-pregnant with 3rd trimester (p= 0.001), 1st with 2nd trimester of pregnancy (p<0.01), 1st with 3rd trimester (p=0.001), 2nd with 3rd trimester (p=0.001).

Among general population, the spleen length was documented by Celiktas et al.[9] and Loftus et al.[10] having 9.87 cm and 9.52 cm respectively which were quite close to the splenic length (96.60 ± 7.40 mm) observed for the control group (non-pregnant) in present study. However, normal splenic length in the non-pregnant female reported slightly larger value by Ugboma et al.[11] and Maymon et al [12] where the length were 10.0 ± 1.8 cm and 10.9 ± 1.5 cm respectively. Another study by Spielmann, et al., spleen length was 10.3 ± 1.3 cm. [13] Mittal et al.[14] obtained a slightly lower value of 9.34 ± 0.95 cm, while, Marco et al.[15] observed a range of 8-11 cm with a median of 9.5 cm of spleen length. In healthy athletes, the mean (SD) splenic length was reported as 10.65 (1.55) cm.[16] Reports indicated variable splenic length but quite close which can be due to the differences in sample size, demographic, anthropometric, geographic or socioeconomic status. The mean splenic length throughout pregnancy in Ugboma et al among Nigerian pregnant women was found to be 10.0±1.8 cm with a median value 9.7 cm. Although, there was no significant increase in mean length across various trimesters, the highest length recorded was 10.08±1.83 cm and lowest length 8.94±0.89 cm occurring in the third trimester. There were changes observed but not significant because of small sample size which was the limitation of the study.[11]

A study in two hundred and eighty-eight women by Maymon et al. reported overall linear increase in splenic size throughout normal pregnancy and presented a statistically significant increment in splenic length (P = 0.039) across pregnancy from first trimester to third trimester and significant positive correlation between gestational age and splenic length: (R = 0.486; p < 0.001).[12] The increase in splenic length observed in the present study was similar to the findings of above study. However, the referenced study was longitudinal, whereas the present study was cross-sectional. Therefore, although the findings are comparable, the difference in study design is limitation.

The mean splenic length for controls were 9.6 ± 1.00 cm in a study by Erohubie OA in Nigeria.[17] The mean splenic length, width and thickness for pregnant subjects were 10.3 ± 1.2 cm. Pregnant subjects were observed to have higher mean splenic length (P = 0.001).[17] A study conducted in Lahore, Pakistan, the splenic length observed during 6-12 week of gestational period was 9.22 ± 1.09 cm followed by 9.74 ± 1.38 cm during 13-27 week and 9.94 ± 1.42 cm during 28-40 weeks suggesting gradual increment in length with advancement of gestational period.18 The mean splenic length was assessed as 9.3±0.6 cm, 9.8±0.3 cm, 9.8±0.3 cm during gestational age 6-12 weeks, 13-27 weeks and 28-40 weeks respectively which was statistically significant (r= 0.37, p= 0.001) suggestive of gradual increase in length with advancement of pregnancy.[4]

Since mild splenic enlargement during pregnancy is inevitable it should be considered as physiological rather than pathological finding. These findings help to establish a normative physiological range for splenic length. Studies demonstrate a small but statistically significant increase in splenic length, particularly during the second and third trimesters, with measurements returning to baseline in the postpartum period. Recognizing these normal physiological changes can assist clinicians in differentiating expected pregnancy related variations from pathological enlargement, thereby aiding in the evaluation of conditions such as anemia, infection, liver disease, and hematologic disorders. Since the study assessed different individuals across trimesters rather than following the

same subject longitudinally throughout pregnancy, individual level changes in splenic length over time could not be evaluated more accurately, and causal inferences cannot be made.

Conclusion

This study revealed measurable changes in splenic length with advancing gestational age. A significant change in splenic length was observed while comparing first with second trimester, first with third trimester and second with third trimester of pregnancy. Awareness of these normal changes is important for radiologists and clinicians to avoid misinterpretation of splenic measurements during pregnancy. Awareness of these normal changes is important for radiologists, clinicians and should interpret splenic length measurements in pregnant women with consideration of gestational age, as a progressive increase in splenic length particularly during the second and third trimesters. It represents a normal physiological adaptation of pregnancy rather than pathology.

Conflict of Interest: None

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