Clinical and Experimental Obstetrics & Gynecology

Original Research

Symphysis-fundal height correlates with adverse delivery and neonatal outcomes in induced full-term and premature pregnancies

Ugo Indraccolo[1,*], Maria Giulia Lombana Marino[2], Beatrice Bianchi[2], Silvia Catagini[2], Danila Morano[3], Pantaleo Greco[2,3]

[1] *Maternal-Infantile Department, Complex Operative Unit of Obstetrics and Gynecology, "Alto Tevere" Hospital of Città di Castello, 06012 Città di Castello (Perugia), Italy*

[2] *Department of Medical Sciences, Section of Obstetrics and Gynecology, University of Ferrara, 44121 Ferrara, Italy*

[3] *Department of Reproduction and Growth, Obstetrics and Gynecology Unit, Azienda Ospedaliero-Universitaria Arcispedale Sant'Anna of Ferrara, 44124 Ferrara, Italy*

*Correspondence: ugo.indraccolo@libero.it (Ugo Indraccolo)

DOI:10.31083/j.ceog.2021.03.2457

Submitted: 8 January 2021 Revised: 11 February 2021 Accepted: 5 March 2021 Published: 15 June 2021

Background: Assessing outcomes of birth in induced patients (full-term and premature) in relation with symphysis-fundal height (SFH) measurement. *Methods*: A prospective enrollment of induced patients was performed at the Obstetrics and Gynecology Unit of Arcispedale Sant'Anna of Ferrara. Reasons for induction, Bishop's score, body mass index, gestational age, parity, mode of induction, number of induction cycles, time of active labor phase, Cesarean section, operative vaginal birth, post-partum hemorrhage, arterial cord pH, neonatal intensive care admission, size at birth were recorded. Correspondence analysis was applied to analyze independent relationships. These relationships were converted into probabilities. Probabilities for outcomes variables were plotted along with values of SFH and trends were tested. *Results*: Significant trends of increasing probability of adverse birth and labor outcomes were observed for SFH from 34 cm or less to over 37 cm: two cycles of induction (best fit $p = 0.002$); three cycles of induction (best fit $p = 0.002$); Cesarean section (best fit $p = 0.027$); higher length of active phase of labor (best fit $p = 0.002$); operative vaginal birth (best fit $p = 0.002$); arterial blood pH below or equal to 7.15 (best fit $p = 0.006$); post-partum minor hemorrhage (best fit $p = 0.002$), post-partum major hemorrhage (best fit $p = 0.006$). *Conclusion*: In induced pregnancies, SFH over 34 cm increased the probability of both neonatal and labor adverse outcomes, independently of gestational age.

Keywords

Symphysis-fundal height; Uterine fundal height; Labor; Delivery outcome; Neonatal outcome

1. Introduction

In the last two decades, many efforts were undertaken to improve estimates of fetal birth size trough sonographic assessment. Customizing fetal chart biometry [1, 2], different formulas for calculating fetal birth weight [3], repeated measurements [4] or probabilistic models [5] have been suggested. Additionally, clinical evaluation of the symphysis-fundal height (SFH) has been tested for predicting both lower and higher birth sizes [6, 7]. While predicting fetal birth size is useful for timing of birth in both low and high birth babies, we have previously shown [8–10] that SFH can predict adverse delivery outcomes in both induced and non-induced labors, independently from fetal weight. These studies, however, only assessed the delivery outcomes in full-term pregnancies. The aim of the present short report is to assess outcomes of birth in induced patients, encompassing also patients not at term, according to SFH values.

2. Methods

A prospective enrollment of a sample of induced patients was performed from January to December 2019 at the Obstetrics and Gynecology Unit of Arcispedale Sant'Anna of Ferrara. SFHs were collected using a tape measure, from the upper rim of the symphysis to the bottom of uterus, with patient in gynecological position.

Reasons for induction (diabetes, hypertensive disorders of pregnancy, intrahepatic cholestasis of pregnancy, oligohydramnios, intra-uterine growth restriction (IUGR)—small for gestational age (SGA), premature rupture of membranes (PROM), obesity, preventing post-maturity syndrome, other indications), Bishop's score, body mass index (BMI), gestational age, parity, mode of induction were collected at the time of the first cycle of induction along with SFH. Number of induction cycles was also collected in the succeeding days. Time of active phase of labor was calculated as a ratio (R) between the time of initiation of partograph to time of birth (expressed in minutes) out of dilatation value (expressed in centimeters) at the time of partogram initiation. Delivery outcome (Cesarean section, operative vaginal birth, post-partum hemorrhage (PPE)), neonatal outcome (arterial cord pH, neonatal intensive care admission (NICU)), birth size ($<$2500 g, between 2500 g and 4000 g, $\geq$4000 g) were

Table 1. Descriptive statistics.

Age (mean ± standard deviation)	32.5 ± 5.54
Gestational age (N, rate)	
-Preterm	15, 8.9%
-Early term	54, 32.0%
-Full term	66, 39.1%
-Late term	35, 20.7%
Parity (N, rate)	
-nullipara	106, 62.7%
-multipara	63, 37.3%
Body Mass Index (mean ± standard deviation)*	
-≤30	141, 83.9%
->30	27, 16.1%
Indication for labor inducing (N, rate)	
-Intra-uterin growth restriction (IUGR) or Small for date (SGA) (N, rate)	17, 10.1%
-Hypertensive disorders	25, 14.8%
-Diabetes	43, 25.4%
-Premature rupture of membranes	42, 24.9%
-Late term gestational age	29, 17.2%
-Obesity	14, 8.3%
-Intrahepatic cholestasis of pregnancy	4, 2.4%
-Olygohydramnios	4, 2.4%
-Others	17, 10.1%
Bishop's score (N, rate)	
-≤3	143, 84.6%
->3	26, 15.4%
Method of first induction cycle of induction	
-Dinoprostone 10 mg vaginal delivery system	23, 13.6%
-Oral misoprostol (50 mg four times)	70, 41.4%
-Both misoprostol and mechanical induction (balloons)	64, 37.9%
-Mechanical induction (balloons)	4, 2.4%
-Oxytocin	8, 4.7%
More than a cycle of induction	
-two cycles	34, 20.1%
-three cycles	135, 79.9%
Labour active phase duration (R)* (mean ± standard deviation)	53.521 ± 63.284
Lower quartile (LQ) (N, rate)	43, 25.4%
Normale range (NR) (N, rate)	43, 25.4%
Upper quartile (UQ) (N, rate)	83, 49.1%
Operative vaginal deliveries (N, rate)	7, 4.1%
Cesarean section (N, rate)	40, 23.7%
Arterial cord pH ≤ 7.15 (N, rate)**	14, 10.4%
Neonatal intensive care unit (NICU) admission***	29, 18.0%
Fetal birth weight	
-≥4000 g (N, rate)	12, 7.1%
-Appropriate birth weight (between 2500 g and 4000 g)	136, 80.5%
-<2500 g (N, rate)	21, 12.4%
Post partum hemorrhage (N, rate)****	
-minor	29, 17.4%
-major	4, 2.4%
Symphysis fundal height	
-≤34 cm (N, rate; mean and standard deviation)	37, 21.9%; 31.4 ± 2.86
-35 cm (N, rate)	16, 9.5%
-36 cm (N, rate)	21, 12.4%
-37 cm (N, rate)	25, 14.8%
->37 cm (N, rate; mean and standard deviation)	26, 15.4%; 39.6 ± 1.81

*One case missing.

**Thirty-five cases missing.

***Eight cases missing.

****Two cases missing.

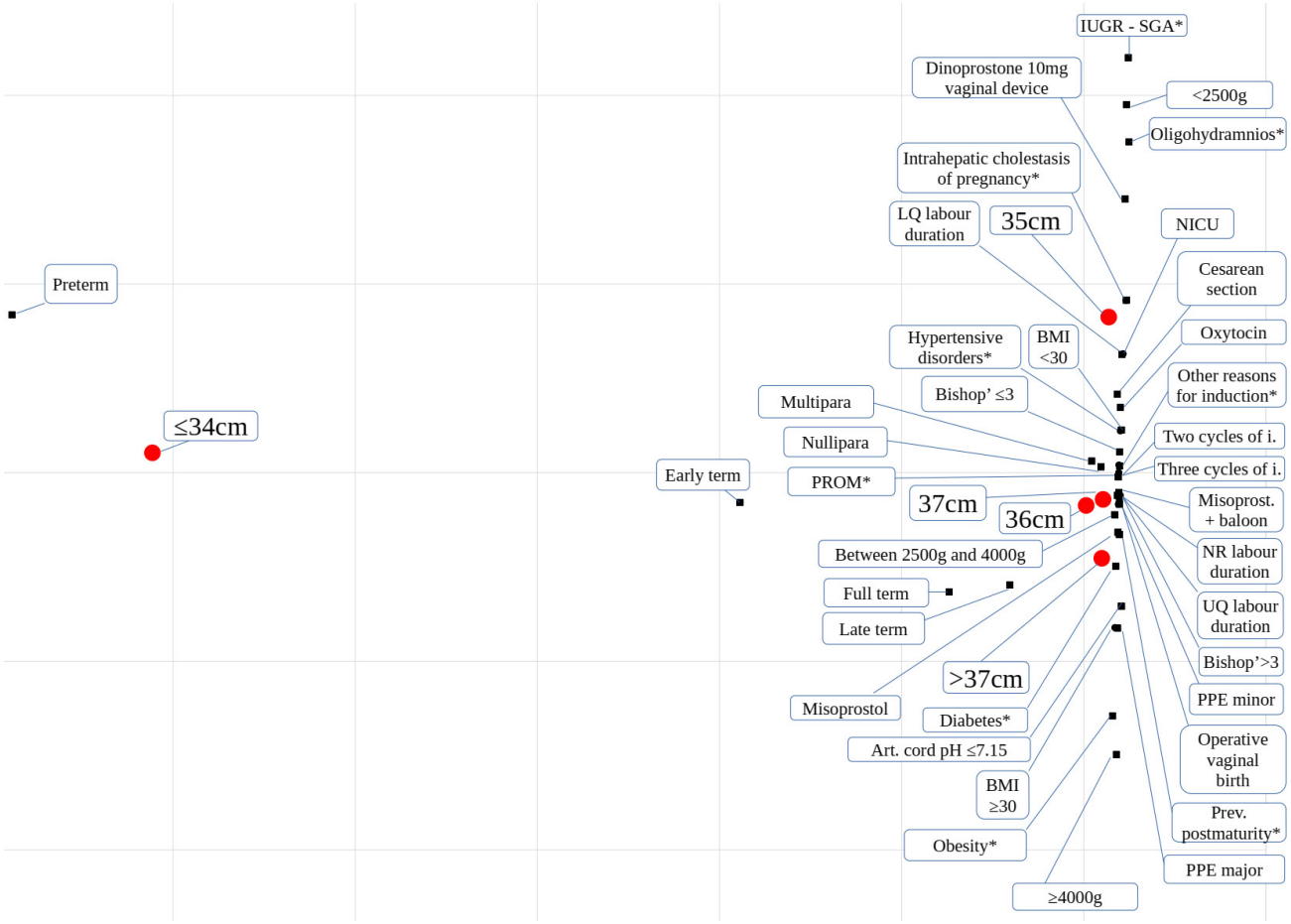

Fig. 1. Perceptual map of two dimensional correspondence analysis. * marks the items as the reasons for induction. Variables are represented as points and grouped in two sets: the red ones (SFH classes) and the blue ones (all other variables assessed). The distances among points are reliable independent estimates of their associations. The closer is a blue dot-point to a red-dot point, the higher is the association. However, the Figure is only descriptive and it does not used for inferential insights. SFH $\leq$ 34 cm is closer to preterm delivery, meaning higher association to preterm inductions. SFH of 36 cm, 37 cm and over 37 cm is closer to two cycles of induction, three cycles of induction, UQ of R, operative vaginal birth, minor post-partum hemorrhage, pH $\leq$ 7.15, diabetes (as the cause of induction), hypertension (as the cause of induction), both Bishop' score $\leq$3 and Bishop' score >3, meaning higher association with those variables.

recorded after delivery.

Intercorrelations among variables were expected. To cancel out the intercorrelations, bi-dimensional correspondence analysis (symmetrical normalization) was applied to find independent relationships among SFH classes ($\leq$34 cm, 35 cm, 36 cm, 37 cm, >37 cm) and other variables. By plotting coordinates given by correspondence analysis for all variables in a Cartesian system, distances between the points were calculated and interpreted as independent probabilities of associations between the independent variable (classes of SFH) and other dependent variables. If distance among a SFH class point and another variable point was 0, the probability of association was 1. The highest distance between a variable point to an SFH class point was rounded to 0 and set for re-scaling all the distances as probabilities.

Probabilities were plotted according to outcome variables (upper quartile (UQ)) of R for the duration of active phase of labor, operative vaginal birth, Cesarean section, minor PPE, major PPE, arterial cord pH, neonatal intensive care (NICU) admission, two cycles of induction, three cycles of induction). Slopes were tested in regression models to find significant fit ($p \leq 0.05$). IBM SPSS statistics 27 and LibreOffice Calc 7.0 were used for the analyses.

3. Results

One-hundred-sixty-nine induced pregnancies were assessed. Inductions were performed preterm, late preterm, early term, full term and late term for various indications. Table 1 describes the samples. Fig. 1 depicts the results of correspondence analysis. Red points represent the positions of SFH classes in relation with other variables (blue points). The closer a blue point is to a red point, the higher the association among the SFH class and that variable. For example, the SFH $\leq$34 cm is closer to preterm delivery, meaning higher association to preterm inductions. On the other hand, SFH of 36 cm, 37 cm and over 37 cm is closer to two cycles of induction,

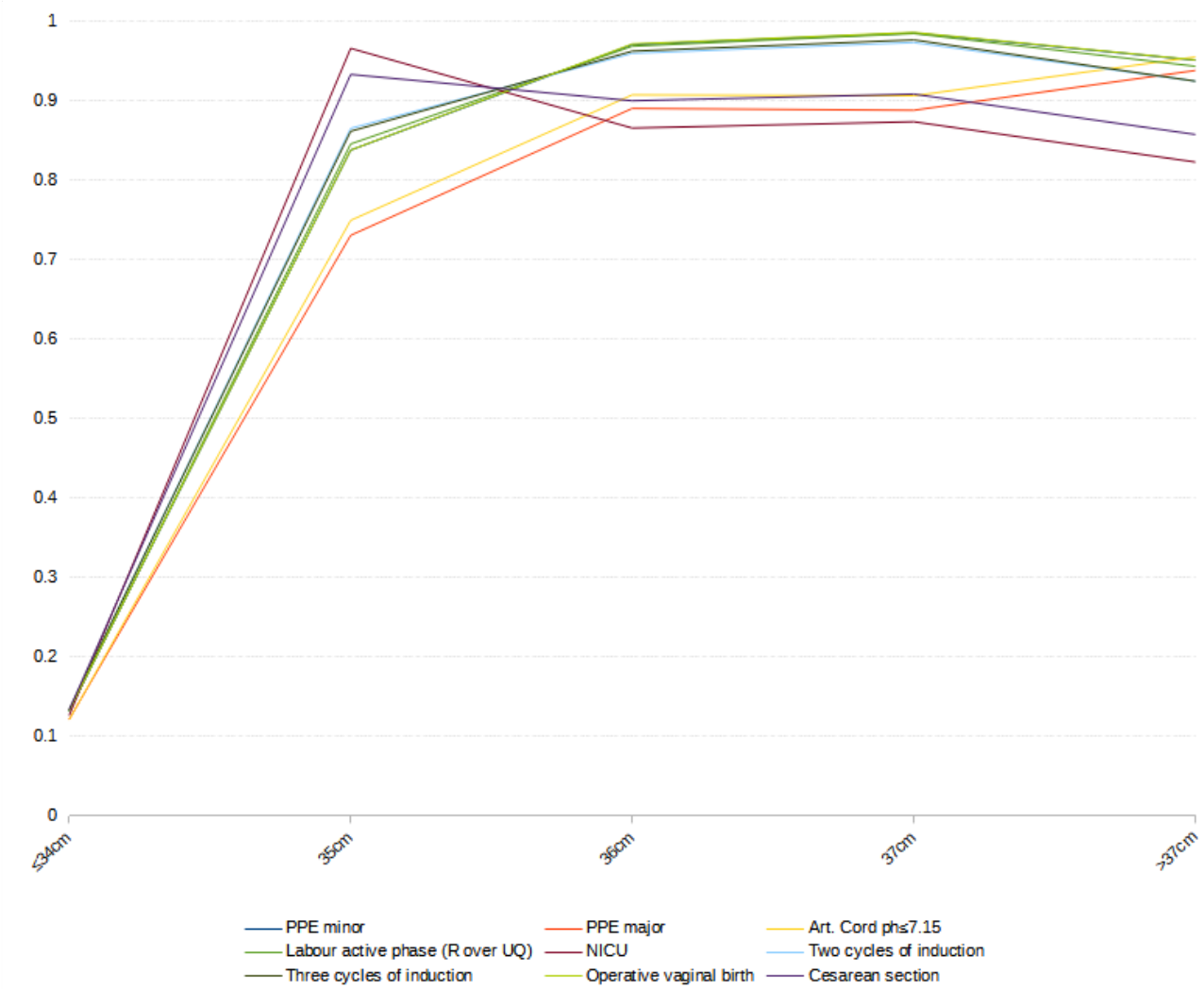

Fig. 2. Trends of birth outcomes according to SFH values. *p* values for each kind of trend assessed. On the y-axis probabilities are reported; on the x-axis SFH values are reported.

three cycles of induction, UQ of R, operative vaginal birth, minor post-partum hemorrhage, pH $\leq$ 7.15, diabetes (as the reason of induction), hypertension (as the reason of induction), both Bishop' score $\leq$3 and Bishop' score >3, meaning higher association with those variables. Fig. 2 reports trends of SFH values for the outcomes variables assessed. Increased probability of adverse birth and labor outcome is observed for the SFH trends from 34 cm or less to over 37 cm. The probabilities increase over 34 cm of SFH value. Table 2 reports significance values for regression trend models for each outcome variable. The quadratic model provides the best prediction compared to other models for all outcome variables. SFH provides poor prediction for Cesarean section (significance trend reached in only the quadratic model, $p = 0.027$) and does not provide any prediction for the NICU admission outcome variables.

4. Discussion

Findings of the present study confirm that SFH (over 34 cm) predicts adverse labor outcomes in induced pregnancies. Additionally, our study suggests that SFH is also able to predict some adverse neonatal outcomes. This study cannot assess if adverse outcomes are linked to a cause-effect relationship with gestational diseases rather than with SFH and its involvement in labor evolution. This is mainly due to communalities among each variables conditioning the outcomes. To assess the SFH association with adverse birth and neonatal outcomes, larger cohort of induced pregnancies should be analyzed, stratifying database for SFH values and comparing outcomes in multivariable models. This is hard to realize. Nevertheless, it is likely that diabetic or hypertensive patients at term with SFH below 34 cm are less likely to be at risk for adverse outcomes compared to diabetic or hypertensive patients with SFH over 34 cm for birth-size related concerns. Remarkably, the finding is poorly associated with neonatal birth weight below 2500 g or over 4000 g (Fig. 1). The re-

Table 2. Regression models for trends.

Outcome	Model					
	Linear	Logarithmic	Inverse	Quadratic	Power	Esponential
PPE minor	0.066	0.053	0.041*	0.002*	0.062	0.077
PPE major	0.036*	0.027*	0.020*	0.006*	0.048*	0.060
Art. cord pH $\leq$ 7.15	0.037*	0.028*	0.021*	0.006*	0.048*	0.061
NICU	0.158	0.136	0.117	0.055	0.099	0.117
Three cycles of induction	0.078	0.063	0.051	0.002*	0.068	0.084
Two cycles of induction	0.080	0.065	0.052	0.002*	0.069	0.085
Cesarean section	0.126	0.106	0.089	0.027*	0.088	0.105
Labour active phase duration over UQ for R	0.070	0.056	0.044*	0.002*	0.064	0.079
Operative vaginal birth	0.066	0.053	0.041*	0.002*	0.062	0.077

p values for regression models are reported. Regressions are built between SFH and probability of the outcome. The best fit is observed for the quadratic model of trend. *means significant results.

sults confirm that SFH cannot be used for predicting birth size [6, 7, 11, 12], leading to strengthen the hypothesis that SFH can predict the birth success [13, 14] by labor induction. Higher SFH values could be related with fetal head station, fetal head deflected positions, unstable positions and malpositions. Those can affect labor progression and onset at the beginning of induction and are not always linked with fetal birth size and Bishop' score (Fig. 1), explaining associations with labor and birth worst outcomes.

In conclusion, SFH values could be useful for timing of induction as it links with birth and neonatal outcomes. As timing of birth is still a concern for patients with gestational diabetes, a randomized trial could be conducted to further examine the timing of induction in pregnancy affected by such a disease.

Author contributions

UI planned the study, analyzed data, wrote article; MGLM, BB, SC collected data and searched literature; MGLM also organized database; DM contributed to plan the study and to write article; PG supervised and gave interpretation to findings. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was conducted in accordance with the Helsinki' declaration and consents were obtained from the patients at the time of recovery.

Acknowledgment

We would like to express my gratitude to all those who helped me during the writing of this manuscript.

Funding

This research received no external funding.

Conflict of interest

The authors declare no conflict of interest.

References

[1] Kiserud T, Johnsen SL. Biometric assessment. Best Practice & Research Clinical Obstetrics & Gynaecology. 2009; 23: 819–831.

[2] Melamed N, Ben-Haroush A, Meizner I, Mashiach R, Glezerman M, Yogev Y. Accuracy of sonographic weight estimation as a function of fetal sex. Ultrasound in Obstetrics & Gynecology. 2011; 38: 67–73.

[3] Hart NC, Hilbert A, Meurer B, Schrauder M, Schmid M, Siemer J, *et al.* Macrosomia: a new formula for optimized fetal weight estimation. Ultrasound in Obstetrics & Gynecology. 2010; 35: 42–47.

[4] Platz E, Newman R. Diagnosis of IUGR: traditional biometry. Seminars in Perinatology. 2008; 32: 140–147.

[5] Miranda J, Rodriguez-Lopez M, Triunfo S, Sairanen M, Kouru H, Parra-Saavedra M, *et al.* Prediction of fetal growth restriction using estimated fetal weight vs a combined screening model in the third trimester. Ultrasound in Obstetrics & Gynecology. 2017; 50: 603–611.

[6] Goto E. Symphysis-fundal height to identify large-for-gestational-age and macrosomia: a meta-analysis. Journal of Obstetrics and Gynaecology. 2020; 40: 929–935.

[7] Goto E. Prediction of low birthweight and small for gestational age from symphysis-fundal height mainly in developing countries: a meta-analysis. Journal of Epidemiology and Community Health. 2013; 67: 999–1005.

[8] Indraccolo U, Chiocci L, Rosenberg P, Nappi L, Greco P. Usefulness of symphysis-fundal height in predicting fetal weight in healthy term pregnant women. Clinical and Experimental Obstetrics & Gynecology. 2008; 35: 205–207.

[9] Chiocci L, Indraccolo U, Matteo M, Mastricci L, Greco P. Symphysis-fundal height may predict difficult labors. Italian Journal of Gynecology & Obstetrics. 2013; 25: 63–65.

[10] Indraccolo U, Nardocci L, Di Iorio R, Bonito M, Indraccolo SR. Symphysis-fundal height predicts difficult evolution of induced labours. Acta BioMedica. 2016; 87: 266–270.

[11] Neilson JP. Symphysis-fundal height measurement in pregnancy. The Cochrane Database of Systematic Reviews. 2000; 1998: CD000944.

[12] Basso NAS, Costa RAA, Dias A, Magalhães CG, Rudge MVC, Calderon IMP. Symphysis-fundal height curve in pregnancies complicated by maternal hyperglycemia: comparison with curves of nondiabetic pregnant women. BioMed Research International. 2020; 2020: 1908764.

[13] Barnhard YB, Divon MY, Pollack RN. Efficacy of the maternal height to fundal height ratio in predicting arrest of labor disorders. The Journal of Maternal-Fetal Medicine. 1997; 6: 103–107.

[14] Alijahan R, Kordi M, Poorjavad M, Ebrahimzadeh S. Diagnostic accuracy of maternal anthropometric measurements as predictors for dystocia in nulliparous women. Iranian Journal of Nursing and Midwifery Research. 2014; 19: 11–18.