# **ORIGINAL ARTICLE**

# Twin Birth weight Discordance and Risk of Preterm Birth

SANA RAJAB HUSSEIN<sup>1</sup>, MAREB HAMID IBRAHIM<sup>2</sup>, SAHBAA MAZIN MAHMOOD<sup>3</sup> <sup>1</sup>Al Khanssa Teaching Hospital, City of Mosul, Iraq. <sup>2</sup>Diploma in Gynaecology and Obstetrics, Al Khanssa Teaching Hospital, City of Mosul, Iraq. <sup>3</sup>Al Batool Teaching Hospital, City of Mosul, Iraq. Correspondence to Dr. Sana Rajab Email: sanaarajab316@gmail.com

# ABSTRACT

**Aim:** To determine whether birth weight discordance is a risk factor for preterm birth of twins and further evaluation of the relationships involved.

**Methods**: This prospective study was carried out in Al-Batool-Maternity Teaching Hospital in Mosul-IRAQ from the 1 of May 2006 to the 30 of April 2007. The study comprised 200 pregnant women with live-born twins delivered at >24 completed weeks of gestation, and all were analyzed for gestational age at delivery, birth weight discordance rate, and it is the percentage. The risk of preterm birth was estimated, and comparison was made between the concordant and discordant groups regarding maternal variables and neonatal outcomes.

**Results**: The degree of discordance correlated strongly with the risk of live preterm birth, especially for discordance > 30% and gestational age < 32 weeks. Among 200 twin pregnancies with discordance 15-19%, 5% of emended in birth <32 weeks gestation versus 40% of discordance, 470 ended in birth at <32 weeks, while 25% of those with Cordance 25-29%, were ended in birth at < 32 weeks, and 30% of OS discordance of> 30% was delivered at < 32 weeks of gestation, respectively y, and only 11.1% of later ended in the birth of > 37 weeks of gestation. There was a statistically significant association weight between twin birth weight discordance and preterm birth and was further strengthened by (final odd Ratio; P < 0.001) in a multivariate model containing other risk factors including maternal age, parity, education, smoking, either twin small for gestation age (SGA), chorionicity and liked fetal sex. Also, the discordant twins had a high rate of the low Apgar score (<7) at one and five minutes for both pair of twin, also a high rate of admission to NICU, and a high rate of early neonatal death, as about 18.4%, 25.3% of first and second twins ended with early neonatal death, respectively.

**Conclusions**: Twin birth weight discordance has now clearly been demonstrated to be a risk factor for preterm birth, and discordance places Twins at increased risk for adverse neonatal outcomes.

Keywords: birth weight, discordance, preterm birth, twins

# INTRODUCTION

Birth weight discordance (BWD) > 20 percent is remarkably common, affecting about 16 percent of twin pregnancies<sup>1</sup>. several researchers studied neonatal morbidity, mortality beyond hospital discharge, and neurodevelopmental outcomes among preterm twins in relation to BWD2,3.. Such studies had small sample sizes, used birth certificate data instead of medical charts, and failed to consider the impact<sup>4</sup>. Weight is affected by environmental factors that differ from one person to another in addition to the inherited characteristics, such as eating and exercise and others<sup>5</sup>. Exposure to these influencing factors may start while the twins are present in the womb of the mother. One of the twin children may get more nutrition through the placenta and start to increase in weight compared to his twin<sup>6</sup>. Data on the neonatal outcomes of discordant twins are primarily based on hospital statistics, and there is scarce data on the outcome of premature discordant twins followed in the post-surfactant neonatal intensive care unit (NICU)<sup>4</sup> May be a more significant threat to the newborn than the birth weight discordance. The uncertainty about the significance of birth weight difference among twins and lack of any reported study in Pakistani national literature led the author to undertake this study. The aim was to study twins with >20% weight difference and their associated factors.

# PATIENTS AND METHODS

A cross-sectional study was carried out in Al-Batool-Maternity Teaching Hospital in Mosul city from the 1 of May 2018 to the 30 of April 2020 and was approved by the committee of obstetrics and gynecology of Iraq commission for medical specialization. Our sample of study composed of two hundred pregnant women with twin gestation, all were seen at the labor and delivery ward where they were admitted in this hospital for having established labor or admitted for induction of labor or elective Caesarean section.

**Patient's characteristics:** All pregnant women in this study with live-born twins delivered at 24 completed weeks of gestation. One day of accurate last menstrual period (LMP) or ultrasonographic assessment performed in the first trimester were used to estimate gestational age.

**Criteria for selection:** Only pregnancies containing live born of both infants were included in the present study. Any twin set with one fetal death was excluded; in addition, those with significant congenital abnormalities, which affected the infant's birth weight, mainly anencephaly, hydrocephalus, were also excluded.

A total of 200 women with a twin pregnancy who met the inclusion and exclusion criteria were recruited and interviewed, and general information was taken from them regarding the Maternal age which was assessed by patient's birth date or their identity, Maternal education in completed years of schooling (primary school, secondary school, college, and uneducated). Obstetric history details about the past obstetric history were taken to clarify gravidity, parity, and disorders complicating pregnancy, including chronic hypertension (including pregnancyinduced hypertension) and family history of twins.

The data regarding characteristics of labor and delivery regarding the mode of delivery whether spontaneous or induced and an indication of induction of labor, also route of delivery, vaginal or Caesarean section whether, elective or emergency cesarean section, The presentation of each twin at labor and specific characteristic of twins were also evaluated, including, mode of conception (spontaneous or by ovulation induction), antepartum ultrasonography, gestational age at delivery in weeks based on either 1s day of accurate last menstrual (LMP) and/or ultrasonographic assessment period performed in prenatal period After delivery birth weight in grams, sex, and Apgar score of each twin at one and five minutes were observed, admission to neonatal intensive care unit (NICU) if needed and it is indication and duration of stay were recorded. Any minor congenital abnormality was looked for, and early neonatal death was also recorded. All newborn admitted to NICU were followed up daily, and those who were discharged, their health was followed up by interviewing their mother either by direct contact or by phoning them for one week after delivery, and then the final outcome was recorded. In each case, the placenta and the membrane separating the amniotic sac examined whether it was monochronic or dichorionic. The following equation calculated birth weight discordance:

"The percentage difference was then categorized into five levels (15%, 15-19%, 20-24%, 25-29%, and 30% or more). These levels were chosen based on the implications of their potential clinical relevance to the neonatal outcome,

and growth restriction from previous studies". Twin birth weight difference of less than 15% was considered nondiscordant (concordant). "The parameter of small for gestational age (SGA) and large for gestational age (LGA) was defined by respective. Birth weight at <10 percentile and > 90" percentile for gestational age among study cases with birth weight discordance and the appropriate for gestational age (AGA) is the birth weight between the 10h and 90h percentile". The comparison was made between discordant and concordant twins regarding the risk of preterm birth. Also, the comparison was made between discordance and concordant twins with regard to various characteristics to evaluate possible associated factors, maternal age, parity, education, history of ovulation smoking, other medical problems during pregnancy, fetal sex, and chorionicity, and the adverse perinatal outcomes between them.

**Statistical analysis:** SPSS 25 was used for the data analysis of the data Standard statistical methods were used to determine the number and percentage. A Chi-square test was used to find the relationships between birth weight discordance and other measured parameters of the neonatal. Fisher Freeman Halton test was used to find the relationships between birth weight discordance and other measured parameters of the neonatal when the Chi-square test cannot be applied. Stepwise forward logistic regression was used for multivariate analysis of the data. Differences between observations were considered significant at p=0.05 or less.

# RESULTS

Table 1: Relationship between twin birth weight discordance percentage and maternal factors

GA (Week)	24-32		33-36		>=37		P-value	
Discordance (%)	No	%		No	%	No	%	
15-19	1	5.0		21	42.9	9	50.0	
20-24	8	40.0		15	30.6	6	33.3	
25-29	5	25.0		8	16.3	1	5.6	<0.001
>=30	6	30.0		5	10.2	2	11.1	
Total	20	100		49	100	18	100	
maternity age (years)		Discor	dant		Concordant			P-value
	N	lo		%	1	lo	%	
18-35	7	7		88.5	ç	92	81.4	
>35	1	0		11.5	2	21	18.6	0.17 (NS)
Total	8	37		100	1	13	100	
Parity	r.				1		n	
0	3	33		37.9	3	39	34.5	
1	2	29		33.3		74	65.5	0.0012
>=2	2	25		28.8	6	63	55.8	
Total	8	37		100	1	13	100	
Using Assistant AS	sing Assistant AS							
Yes	5	0		57.5	2	39	34.5	0.0040
No	3	7		42.5	-	74	65.5	0.0012
Total	8	7		100	1	13	100	
Risk factors		Dis	scord	lant		Concordant		P-value
		No		%	1	lo	%	
Smoking	Yes	16		18.4		8	7.1	
	No	71		81.6	1	05	92.9	0.015
Total		87		100	1	13	100	
Hypertension	Yes	31		35.6	2	21	18.8	P-value
	No	56		64.4	Q	91	81.3	
Total		87		100	1	13	100	0.007

#### Table 2: Relationship between twin birth weight discordance percentage and child factors

Sex	Di	scordant	Conc	ordant	P-value
	No	%	No	%	
Both male	24	27.6	37	32.7	
Both female	32	36.8	31	27.4	0.36 (NS)
Male-female	31	35.6	45	39.9	
Total	87	100	113	100	
Weight sequence normality					
AGA-AGA	32	36.8	85	75.2	
SGA-AGA or LGA	18	20.7	7	6.2	<0.001
SGA-AGA	7	8.0	10	8.8	
AGA or LGA-SGA	19	21.8	9	8.0	
AGA-LGA	11	12.6	2	1.8	
Total	87	100	113	100	
Chronicity					
Monochromic	45	51.7	24	21.2	
Dichroitic	42	48.3	89	78.8	<0.001
Total	87	100	113	100	
Twin presentation					
Cephalic- Cephalic	27	31.0	32	28.3	
Cephalic- Breech	41	47.1	42	37.2	0.018(NS)
Breech- Cephalic	4	4.6	13	11.5	
Breech- Breech	15	17.3	26	23.0	

Table 3: Relationship between each mode of delivery, route of delivery, and an indication of C/S with twin birth weight discordance.

•		,	Dis	cordant	Conc	ordant	P-value	
			No	%	No	%		
Mode of delivery	Spontane	eous labor	81	93.1	85	75.2		
	Indu	uced	6	6.9	28	24.8	0.001	
	Total		87	100	113	100		
Route of delivery	Vaginal delivery		66	93.1	72	63.7		
-	C	s/S	21	6.9	41	36.3	0.07(NS)	
	To	Total		100	113	100		
Indication of C/S	Ele	Elective		9.5	15	36.6		
	Emer	gency	19	90.5	26	63.4	0.024	
	To	otal	21	100	41	100		
Order	Time(Min)	Apgar Score					•	
1 <sup>st</sup>	1	≥7	15	17.2	33	29.2		
		<7	72	82.8	80	70.8	0.02	
	Total		87	100	113	100		
1 <sup>st</sup>	5	≥7	45	51.7	84	74.3		
		<7	42	48.3	29	25.7	<0.001	
Total			87	100	113	100		
2 <sup>st</sup>	1	≥7	26	29.9	55	48.7		
		<7	61	70.1	58	51.3	0.007	
Total			87	100	113	100		
2 <sup>st</sup>	5	≥7	46	52.9	80	70.8		
		<7	41	47.1	33	29.2	0.009	
Total			87	100	113	100		
Twin Order	NIC	CUA						
1 <sup>st</sup>	Y	es	55	63.2	40	35.4		
	Ν	lo	32	36.8	73	64.6	<0.001	
Total		87	100	113	100			
2 <sup>st</sup>	Y	es	52	59.8	34	30.1		
	Ν	10	35	40.2	79	69.9	<0.001	
Total		87	100	113	100			
RDS								
1 <sup>st</sup>	Y	es	39	44.8	17	15.0	<0.001	
	N	lo	48	55.2	96	85.0		
Total			87	100	113	100		
2 <sup>st</sup>	Y	es	33	37.9	17	15.0	<0.001	
	n	10	54	62.1	96	85.0		
I otal			87	100	113	100		
Early neonatal dea	th			10.1			0.00/	
15	Y	es	16	18.4	3	2.7	<0.001	
Tatal	N	10	/1	81.6	110	97.3		
IOTAI			87	100	113	100	0.004	
25	Y	es	22	25.3	2	1.8	<0.001	
	n	10	65	/4./	111	98.2		

variable	D	P-value	UR	<b>U.I.</b>
Discordance	1.366	<0.001	3.92	2.27-6.77
Parity	-0.40	0.027	0.67	0.47-0.95
Presentation	0.076	0.015	1.08	1.02-1.15
Chronicity	-1.227	<0.001	0.29	0.16-0.53

B= Coefficient of each variable in the model, + sign represent direct effect - sign represent inverse effectOR= odd Ratio, the value of less than 1 indicates protective effect while values more than 1 represent risk effect.C.I = 95% Confidence interval.

#### DISCUSSION

Intra-twin birth weight discordance is widespread in twin pregnancies. The frequency of birth weight discordance varies by definition, ranging from ten percent if birth weight difference 25 percent were defined as discordance) to thirty percent (if birth weight difference 15 percent was defined as discordance<sup>7</sup>. A total of 200 eligible twins were included in this analysis, the gestational age distribution in our study was 120(60%) <37 weeks and 80(40%) >37 weeks, and the mean gestational age for the twin sets were 35.4+2.8 weeks during the study period, as shown in Table 1. While a study conducted by Wen S.W. et al<sup>8</sup> from ANZJ obstetric and gynecology in October 2006, reported that the twin preterm birth rate was 64.3% and compared to the study done by Pongdanich W. and Dittakran et al<sup>9</sup>, 2006 that the mean gestational age of twin birth at delivery was 35.9+2.6 weeks. The number of twins with birth weight discordance was 87(43.5%), while the number of concordant twins 113(56.5%), as shown in Table 1. Several studies had evaluated potential associated factors for fetal growth discordance, and some of them incidentally noted an association between birth weight discordance and preterm birth. In contrast, in the current study, the data were used to explain the magnitude of the association, the degree of discordance needed, and the gestational age affected with greater precision. The present study demonstrated a statistically significant inverse relationship between twin birth weight discordance and gestational age, the greater birth weight discordance, the more risk of preterm delivery, as shown in Table 2. Delivery rates between 24-32 weeks of gestation, was 5%, 40%, 25%, and 30% in discordant twins subsequently. According to the level of discordance related (15-19%, 20-24%, 25-29% and 30%) respectively. While delivery rates between (33-36) weeks of gestation, was 42.9%, 30.6%, 16.3%, and 10.2% among the discordant group subsequently. The same Table also showed that the delivery rates at >37 weeks, was 50%, 33.3%, 5.6%, and 11.1% among discordant twins Subsequently. Victoria A. et al<sup>10</sup> also observed a similar finding, as they observed that approximately one-fifth of all twin birth delivered preterm < 32 weeks of gestation) and risk increase significantly with birth weight discordance of> 20%-30%). The relation between twin birth weight discordance and maternal age was reported in this study as shown in Table 3 that the discordance percentage was more in the age group (18-35) years (88.5%) while those> 35 years had only (11.5%) of the discordant rate. However, there was no difference concerning the concordant twins. This result was agreed with the study conducted by Yinon Y. et al<sup>11</sup>, in 2005, stated that maternal age did not show a significant risk factor for twin birth weight discordance, while another study showed that maternal age had the least effect on the intra twin birth weight discordance by Tan H. et al<sup>12</sup>. The relation between birth weight

discordance and parity had been evaluated in the current study, which demonstrates that there is a significant relationship between twin birth weight discordance and parity as shown in Table 4, as a higher rate of discordance was in nulliparous than multiparous women this also confirmed by the hypothesis that based on the notion that the uteri of multiparous are more efficient promotes of twin growth than those of primiparous. This also confirmed by a study done in 200713 that nulliparity was significantly associated with birth weight discordance. This study also demonstrates that the use of ovulation induction was associated with a statistically significant relationship with the birth discordance weight as 57.5% of women with twin birth weight discordance had a history of ovulation induction while 34.5% of those with concordant twin with history of ovulation induction. This risk factor is also confirmed by Audibert F. et al<sup>14</sup>. In 2002, that ovulation induction is a significant risk factor for twin birth weight discordance same result was also obtained by Zadori J. et al<sup>15</sup> in October 2004. Wen S.W. et al<sup>12</sup> on 2006 analyzed the database of twin birth in the university of Ottawa-Canda for the period 1995-1997, the authors showed that maternal smoking and maternal hypertension have a significant risk factor of twin birth weight discordance, similar to the current study, which demonstrates there was a significant relationship between maternal hypertension including pregnancy-induced hypertension, and twin birth weight discordance, also there is a strong association between maternal smoking and rate of discordance as 18.4% of women with discordant twin had a history of smoking in contrast to only 7.1% of concordant twins. The result of the current study demonstrates that there was no statistically significant relationship between twin birth weight discordance and the gender of twin pair, although about 36.8%, discordant twins were female-female pair, 35.6% in male-female pair and 27.6% of male-male pair respectively, this did not reach the statistical significant. As compared to finding stated by Ananth C.V. et al<sup>16</sup>, they found twin birth weight discordance more in liked-sex twins as compared to unlike-sex twins) (31). Regarding the fetal factors that influence twin birth weight discordance, this study shows the closely intertwined relationship between fetal growth of the individual twin and birth weight discordance of the pair, smaller twins of highly discordant pairs to high rate of (SGA) in one of the twins as the rate of SGA in one pair was (20.7%) and (21.8%) among discordant twins while (62 %) and (8.0%) among concordant twins, respectively. Similar to the finding of this study, Branum A.M. et al<sup>17</sup>, found the same association between fetal growth and twin birth weight discordance and also agreed by Cooperstock M. S. et al<sup>18</sup>. Other factor has been evaluated in our study, is the distribution of discordance according to twin order. About 60.5% of discordance was attributed to the second twin, this fact also had been proved by Blickesti I et al., in July 1987<sup>19</sup> and then this fact also supported recently by

Hacking D. et al., study<sup>20</sup>. This analysis also showed a clear and significant relation between chorionicity and birth weight discordance, about (21.2%) of concordant twins were monochorionic. In comparison (51.7%) of discordant twins were monochorionic, so the discordance rate was more in monochorionic twins than the dichorionic one Pongpanich W. et al<sup>9</sup>, and Victoria A. et al<sup>10</sup>, found that severe discordance occurs. significantly more often in monochorionic twins than dichorionic twins. The twin presentation in the current study was the higher percentage of the discordant twin is with the cephalic-breech presentation (47.1%) of discordant twins were cephalicbreech presentation while (37.2%) of the concordant twin was with the cephalic-breech presentation. Hollier L. M. et al<sup>21</sup> concluded that twin fetal presentation was significantly related to twin birth weight discordance specifically. Presentations other than cephalic-cephalic were more frequent as discordance increased. The current study found about (93.1%) of discordant twins were admitted to labor ward with spontaneous labor, and only 6.9% of them had induced labor contrast to concordant twins, this result support the higher rate of preterm delivery among discordant twins<sup>13</sup>, and about 75.9% of discordant twins were delivered while (24.1%) of them had cesarean section compared to (72%) and (41%) of their counter part of twins with no discordan significant relation between rout of delivery and discordance. Kontopoulos et al<sup>22</sup> also concluded this finding, on January 2005. While Amaru R.C. et al<sup>23</sup> found that discordant twins were morel likely to have a caesarean delivery. The study demonstrates that both pair of the discordant twin had low Apgar score (<7) at both one and five minutes as compared to concordant twins, this consistent with the result conducted by Hartley K. et al<sup>24</sup> and Victoria A., et al<sup>30</sup>, that frequency of low Apgar score (7) were more in discordant twin birth. With regard to neonatal outcomes among discordant twins, the study demonstrates that twin birth weight discordance was a significant predictor of adverse neonatal outcomes with regard to Apgar score of twin pair, neonatal intensive care unit (NICU) admission, respiratory distress and early neonatal death. The rate of NICU admission rate was higher (63.2%) among discordant twins as compared to 35.4% in concordant twins, this agreed by the study done by Kilic M., et al<sup>25</sup>, on May 2006 and also Amarue RC. et al that more NICU admission among discordant twins than concordant one. In addition the rate of respiratory the rate of respiratory distress syndrome (RDS) was high between both members of discordant twin in comparison to concordant twins; this result was similar with Hacking D et.al study. The important significant relationship was demonstrated in this study between twin birth weight discordance and early neonatal death. The rate of early neonatal death was 18.4% among the 1st twin of discordant pair and 25.3% in the 2<sup>nd</sup> twin as compared to concordant twins (2.7%) and (1.8%) respectively.

#### REFERENCES

 Dolgun ZN, Inan C, Altintas AS, Okten SB, Sayin NCJPjoms. Preterm birth in twin pregnancies: Clinical outcomes and predictive parameters. 2016;32(4):922.

- Boghossian NS, Saha S, Bell EF, Brumbaugh JE, Shankaran S, Carlo WA, et al. Birth weight discordance in very low birth weight twins: mortality, morbidity, and neurodevelopment. 2019;39(9):1229-40.
- SIZE HOB, POOLED AJTR, Genetics H. on Twin Studies and the 4th World Congress on Twin Pregnancy, Madrid, Spain November 16– 18, 2017. 2017;20(6):564-642.
- Piercy JC. Twin Gestation And Neuropsychological Outcome Of Preschool-Age Children Born Prematurely. 2015.
- Carter BM. Identification of risk factors for necrotizing enterocolitis in preterm infants: how race, gender, and maternal health status contribute. 2009.
- Craig JM, Sutton EK, Jahanfar S. The environmental differences between twins in utero and their importance for downstream development: a need for standardized monitoring in obstetric research. Developmental and Fetal Origins of Differences in Monozygotic Twins: Elsevier; 2020. p. 320-43.
- Miller J, Chauhan SP, Abuhamad AZJAjoo, gynecology. Discordant twins: diagnosis, evaluation, and management. 2012;206(1):10-20.
- Wen SW, Tan H, Yang Q, Walker MJG, investigation o. Prediction of intra-twin birth weight discordance by binary logistic regression analysis. 2006;62(4):186-92.
- Pongpanich W, Borriboonhirunsarn DJJ-MAOT. Prevalence and associated factors of discordant twins in Siriraj Hospital. 2006;89(3):283.
- Victoria A, Mora G, Arias FJO, Gynecology. The perinatal outcome, placental pathology, and severity of discordance in monochorionic and dichorionic twins. 2001;97(2):310-5.
- Yinon Y, Mazkereth R, Rosentzweig N, Jarus-Hakak A, Schiff E, Simchen MJJO, et al. Growth restriction as a determinant of outcome in preterm discordant twins. 2005;105(1):80-4.
- Wen SW, Tan H, Walker MJA, obstetrics NZjo, gynaecology. The association between intratwin birthweight discordance and preterm birth in twin pregnancy. 2006;46(5):402-6.
- Belogolovkin V, Engel SM, Ferrara L, Eddleman KA, Stone JLJJouim. Does sonographic determination of placental location predict fetal birth weight in diamniotic-dichorionic twins? 2007;26(2):187-91.
- Audibert F, Boullier M, Kerbrat V, Vial M, Boithias C, Frydman RJJdg, obstetrique et biologie de la reproduction. Growth discordance in dichorionic twin pregnancies: risk factors, diagnosis and management. 2002;31(1 Suppl):2S15.
- Zádori J, Kozinszky Z, Orvos H, Katona M, Kaáli SG, Pál AJJoar, et al. Birth weight discordance in spontaneous versus induced twins: impact on perinatal outcome. 2004;21(3):85-8.
- Jacobs AR, Demissie K, Jain NJ, Kinzler WLJO, Gynecology. Birth weight discordance and adverse fetal and neonatal outcomes among triplets in the United States. 2003;101(5):909-14.
- Branum AM, Schoendorf KCJO, Gynecology. The effect of birth weight discordance on twin neonatal mortality. 2003;101(3):570-4.
- Cooperstock MS, Tummaru R, Bakewell J, Schramm WJAjoo, gynecology. Twin birth weight discordance and risk of preterm birth. 2000;183(1):63-7.
- Blickstein I, Goldman R, Smith-Levitin M, Greenberg M, Sherman D, Rydhstroem HJO, et al. The relation between inter-twin birth weight discordance and total twin birth weight. 1999;93(1):113-6.
- Hacking D, Watkins A, Fraser S, Wolfe R, Nolan TJAoDiC-F, Edition N. Respiratory distress syndrome and birth order in premature twins. 2001;84(2):F117-F21.
- Hollier LM, McIntire DD, Leveno KJJO, Gynecology. Outcome of twin pregnancies according to intrapair birth weight differences. 1999;94(6):1006-10.
- Kontopoulos EV, Ananth CV, Smulian JC, Vintzileos AMJAjoo, gynecology. The influence of mode of delivery on twin neonatal mortality in the US: variance by birth weight discordance. 2005;192(1):252-6.
- Amaru RC, Bush MC, Berkowitz RL, Lapinski RH, Gaddipati SJO, Gynecology. Is discordant growth in twins a n independent risk factor for adverse neonatal outcome? 2004;103(1):71-6.
- Hartley RS, Hitti J, Emanuel IJAjoo, gynecology. Size-discordant twin pairs have higher perinatal mortality rates than nondiscordant pairs. 2002;187(5):1173-8.
- Kilic M, Aygun C, Kaynar-Tuncel E, Küçüködük ŞJJop. Does birth weight discordance in preterm twins affect neonatal outcome? 2006;26(5):268-72