Influence of Socioeconomic Levels on Birthweight of Twins and Singletons

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This study aimed to compare birthweight distribution of twins and singletons from three different socioeconomic level hospitals and evaluate the possible contribution of assisted reproduction technologies (ART). Data for twins and singletons were collected in the 1990s from hospitals A (370 twins, 370 singletons), B (306 twins, 306 singletons), and C (562 twins, 562 singletons). Only hospitals B and C have ART procedures. Gestational age was significantly lower in hospital C for singletons and twins. Birthweight for singletons was lower at hospital A ($p < .005$ for hospital B and $p = .000$ for hospital C); however, birthweight for twins was lower for hospitals A and C compared to hospital B ($p = .000$ for both comparisons). There were no differences between the mean birthweight for singletons and twins either to primigravidae or multigravidae in hospital A; nevertheless, for B and C the mean birthweight of twins was significantly lower in primigravidae than in multigravidae ($p = .029$ and $p = .006$, respectively). Considering twins up to 37-weeks of gestational age, hospital C showed the highest percentage of twin births (73.3%). These data suggest that the use of ART accounts for a disproportionate number of low birthweight and/or premature infants in primigravidae of higher socioeconomic level.

On average, twins are born with lower gestational age and lighter weight than singletons (Beiguelman et al., 1998; Bleker et al., 1988; Buckler & Buckler, 1987; Colletto et al., 2003; Gedda et al., 1981; Keith, 1994; Luke et al., 1991; Luke, 1996). When twins and singletons are distributed into three classes of birthweight (less than 1500g, between 1500 and 2500g, and more than 2500g), the proportion of newborns with low and very low birthweight is dramatically higher than that among singletons (Colletto et al., 2003).

Perinatal mortality is strongly influenced by low birthweight, due to its association with respiratory, metabolic, immunologic and neurologic disorders (Chandra, 1975; Harper & Wiener, 1965; Keith et al., 2000). Since the rate of perinatal deaths is disproportionately high among twins (Keith, 1994; Luke, 1996) one might suppose that this could merely be a consequence of their low birthweight. However, the data from Luke (1996) confirmed Gedda et al.'s (1981) claim that low birthweight in twins and in singletons are not comparable and have different implications for child growth and survival.

In Brazil, the treatment of women with ovulation-inducing hormones with or without subsequent in vitro fertilization is mostly performed in private clinical settings. Therefore, one may suppose that private hospitals servicing women from a high socioeconomic background would include a high proportion of those who had undergone assisted reproduction technologies (ART), which is associated with multiple births (Colletto et al., 2001; Colletto, 2003; Colletto et al., 2003) and which has grown in the last decade.

In a recent paper, Colletto et al. (2003) showed that the fetal death rate decreased as the socioeconomic level increased, but twin/singleton fetal death ratio is three-fold times greater in the higher socioeconomic level hospital, suggesting that even under the ideal conditions of medical and hospital facilities, the mortality of twins continues to be much higher than that of singletons.

The present study compares the birthweight distribution of twins and singletons born to mothers of three different socioeconomic backgrounds, after adjustment of these weights by multiple regression analysis to gestational ages.

Subjects and Methods

The study focused on the singleton and multiple births that occurred in the 1990s at three hospital facilities in the city of São Paulo, attending populations from different socioeconomic levels, and scored as follows: Hospital A — very low level, is a foundation for poor people without any type of social security; Hospital B — medium level, is a private

Received 14 August, 2003; accepted 12 December, 2003.

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institution servicing middle class stratum people; and Hospital C — high level, is also a private institution servicing high social class individuals, which were classified according to their educational degree (Alonso et al., 1997; Zurayk et al., 1987). Mothers at hospital A were indigent and did not receive any type of assisted-reproduction or hormone intake treatment aiming at fertilization. At this hospital the twinning rate was 0.8% for the 1990s, which was considered the "natural" rate when compared to the literature (Beiguelman et al., 1996; Colletto et al., 2003). On the other hand, it is known that hospital B, besides assisting people with social securities, offers ART to mothers who can afford the costs. At this hospital the twinning rate was 1.16% (Colletto et al., 2003). Hospital C has a Center for Human Reproduction where all types of ART are offered at very high costs, which increased the twinning rate from 1.4% in 1990 to 2.8% in 1999 (Colletto et al., 2003).

During this period, the following data were collected: at Hospital A 370 twins and 370 singletons, at Hospital B 306 twins and 306 singletons, at Hospital C 562 twins and 562 singletons. The singletons were the prior and the consecutive maternity of each twin birth, and data on gestational age, sex and weight at birth were collected.

Mean and standard deviation (*SD*) estimates, Student's *t* test, analysis of variance followed by multiple comparison test (Least Significance Difference [LSD]), non-parametric tests (Kruskal-Wallis and Dunn), and regression analysis were performed using SPSS 9.0.

Results

We compared both sex distributions within the three hospitals, and there was no significant difference between them, both for single births ($\chi^2 = 2.30$; $p = .317$) and twins ($\chi^2 = 2.66$; $p = .264$). Therefore, data for both sexes were jointly analyzed.

Gestational age, whose means and standard deviations are shown in Table 1, when analyzed with the Kruskal-Wallis test (K-W) was shown to be significantly different among the three hospitals, both for singletons ($\chi^2 = 19.36$; $p = .000$) and for twins ($\chi^2 = 41.44$; $p = .000$). By applying the multiple comparison test (Dunn) between two hospitals at a time, it was noticed that the gestational age at hospital C was significantly lower than that at hospital A, both for singletons ($p < .001$) and twins ($p < .05$), and also lower as compared to gestational age at hospital B ($p < .05$ for singletons and twins). There was no remarkable difference as regards gestational age for both types of birth between hospitals A and B.

The cesarean rates at hospital A were 28.8% for singletons and 66.3% for twins; at hospital B were 81.9% for singletons and 87.3% for twins; and at hospital C were 67.1% for singletons and 89.3% for twins.

As regards weight at birth, whose means and standard deviations are shown in Table 2, the analyses depicted figures significantly different among the three hospitals when submitted to the analysis of variance test, both for singletons ($F = 6.997$, $p = .001$) and twins ($F = 9.058$, $p = .000$). The multiple comparison tests (LSD) showed a noticeable lower mean for singletons at hospital A, as compared to hospitals B and C ($p = .005$ and $p = .000$, respectively), however, no difference was noted between B and C. Meanwhile, for the twins, there was an inversion of results: hospitals A and C showing means significantly lower than those for hospital B ($p = .000$ for both comparisons), and the means for hospitals A and C did not differ.

To evaluate the influence of cesarean section (CS) on birthweight, *t* tests and their respective *p* values were calculated between normal and CS for singletons and twins at the three hospitals (Table 3). Among singletons, no significant difference for birthweight was found between the types of birth at the three hospitals. However, for twins, the mean birthweight for CS was significantly higher at the three hospitals. To explain this data the mean of gestational age was calculated for singletons and twins, according to the type of birth at the three hospitals (Table 4). As it could be anticipated, gestational age for twins was significantly higher for CS than for normal birth, while for singletons there was no difference.

These figures led to the study of weight at birth of singletons and twins born to primigravidae and multigravidae mothers. The birthweight for each type of delivery within the same hospital was compared, between primigravidae and multigravidae mothers. Table 5 depicts these results. Means for primigravidae and multigravidae were not different for singletons,

Table 1

Number of Births, Mean and Standard Deviation (*SD*) of Gestational Age for Singletons and Twins, According to Three Hospitals of Different Socioeconomic Level

	Singletons			Twins		
Hospital	*N*	*M*	*SD*	*N*	*M*	*SD*
A	370	38.80	2.52	370	36.39	3.58
B	306	38.92	1.73	306	36.68	2.49
C	562	38.65	1.77	562	35.85	2.62
K-W test	$\chi^2 = 19.36$, $p = .000$			$\chi^2 = 41.44$, $p = .000$		

https://doi.org/10.1375/twin.7.2.128 Published online by Cambridge University Press

Table 2

Number of Births, Mean and Standard Deviation (*SD*) of Birthweight for Singletons and Twins, According to Three Hospitals of Different Socioeconomic Level, and the Results of Analysis of Variance (*F*), with their Respective Probability (*p*)

		Singletons			Twins	
Hospital	*N*	*M*	*SD*	*N*	*M*	*SD*
A	370	3107.95	549.56	370	2262.91	617.90
B	306	3217.84	476.94	306	2439.57	526.74
C	562	3228.72	486.02	562	2304.68	563.96
Test F		$F = 6.997$, $p = .001$			$F = 9.058$, $p = .000$	

Table 3

Mean, Standard Deviation, *t* test and Respective Probabilities to Compare the Birthweight According to the Type of Delivery for Singletons and Twins at Hospitals A, B and C

			Singletons				Twins		
	Type of delivery	*N*	*M* ± *SD*	*t*	*p*	*N*	*M* ± *SD*	*t*	*p*
Hospital A	Normal	264	3093.9 ± 561.0	0.75	.456	124	2069.4 ± 704.9	4.20	.000
	CS	106	3141.2 ± 526.5			246	2371.1 ± 528.8		
Hospital B	Normal	55	3174.0 ± 485.5	0.34	.737	39	1872.9 ± 686.0	3.71	.000
	CS	251	3230.3 ± 603.6			267	2411.3 ± 478.1		
Hospital C	Normal	185	3245.0 ± 450.6	0.67	.501	60	2064.6 ± 589.9	3.71	.000
	CS	377	3216.3 ± 514.1			502	2328.8 ± 512.9		

Table 4

Mean, Standard Deviation, *t* test and Respective Probabilities to Compare the Gestational Age According to the Type of Delivery for Singletons and Twins at Hospitals A, B and C

			Singletons				Twins		
	Type of delivery	*N*	*M* ± *SD*	*t*	*p*	*N*	*M* ± *SD*	*t*	*p*
Hospital A	Normal	264	38.7 ± 2.7	1.15	.251	124	35.3 ± 4.7	4.40	.000
	CS	106	39.0 ± 1.9			246	37.0 ± 2.6		
Hospital B	Normal	55	38.5 ± 2.2	0.64	.523	39	33.7 ± 4.1	2.28	.038
	CS	251	38.1 ± 2.5			267	36.3 ± 2.6		
Hospital C	Normal	185	38.6 ± 2.3	0.49	.627	60	34.6 ± 3.4	2.93	.005
	CS	377	38.7 ± 1.5			502	36.0 ± 2.5		

or for twins born at hospital A lacking assisted reproduction procedures. However, at hospitals B and C, the average weight at birth for twins born to primigravidae was remarkably lower than that of births to multigravidae ($p = .029$ and $p = .006$, respectively), and at Hospital C the incidence of primigravidae among twins was higher than that of multigravidae, which was unexpected (Table 5).

Intrauterine Growth Curves

Multiple regression analyses of the natural logarithm transformation of weight at birth on gestational age (GA), square gestational age (GA^2) and third power gestational age (GA^3) were carried out and have shown that the more effective results for adjustment purposes were obtained by GA and GA^3. From these data intrauterine growth curves for singletons and twins were developed. These curves are shown in Figures 1 and 2 respectively, and depict that, at singleton average gestational age (approximately 39 weeks), hospital C has its curve above that of B and A. However, when examining the twin figure at the average gestational age (approximately 36 weeks), the curve for hospital C is practically superposing that of Hospital A, no difference therefore being noted between them.

For the singletons' curve, one can notice that the highest socioeconomic level hospital (C) had its growth curve slightly below that of the intermediate socioeconomic level hospital up to 36-week gestational age, at the time when both curves cross each other. From then on, the highest level hospital curve shows higher birthweight for singletons, whereas the curve for the intermediate level hospital follows

Table 5

Mean, Standard Deviation and Number of Maternities (Including Percentage) of Birthweight for Singletons and Twins Separately, According to Birth Order (Primigravidae and Multigravidae), and the *t* test with the Respective Level of Significance (*p*)

		Primigravidae		Multigravidae			
Maternities	Hospital	*M* ± *SD*	*N* (%)	*M* ± *SD*	*N* (%)	*t*	*p*
Singletons	A	3098.87 ± 500.11	163 (45.3)	3103.53 ± 594.59	197 (54.7)	0.08	.936
	B	3181.31 ± 508.15	107 (35.1)	3236.46 ± 460.34	198 (64.9)	0.96	.337
	C	3217.16 ± 465.33	219 (39.0)	3245.94 ± 476.52	340 (61.0)	0.70	.482
Twins	A	2231.53 ± 553.59	137 (37.5)	2279.84 ± 656.36	229 (62.5)	0.72	.471
	B	2353.85 ± 500.35	117 (38.6)	2487.86 ± 529.31	187 (61.4)	2.19	.029
	C	2243.48 ± 522.11	289 (51.9)	2365.45 ± 523.46	268 (48.1)	2.75	.006

that of the lowest level hospital, a little bit above it. Among twins there was a similar situation. However, as they were born averaging 36-weeks gestational age, the twins at hospital C had their mean birthweight below that of those at the intermediate level hospital, as confirmed by the multiple comparison tests aforementioned, and were not different from the twins at the lower level hospital (A).

When considering the twins of gestational age up to 37 weeks, it was noted that they corresponded to 55.7% of twins at hospital A, 57.5% at hospital B and 73.3% at hospital C, that is, at the highest socioeconomic level hospital most of the twins were born with up to 37-weeks gestational age with a birthweight averaging 2,166.35g, which is much below the desirable figures, even for twins, whose birthweight should be around 2,500g (Luke, 1996).

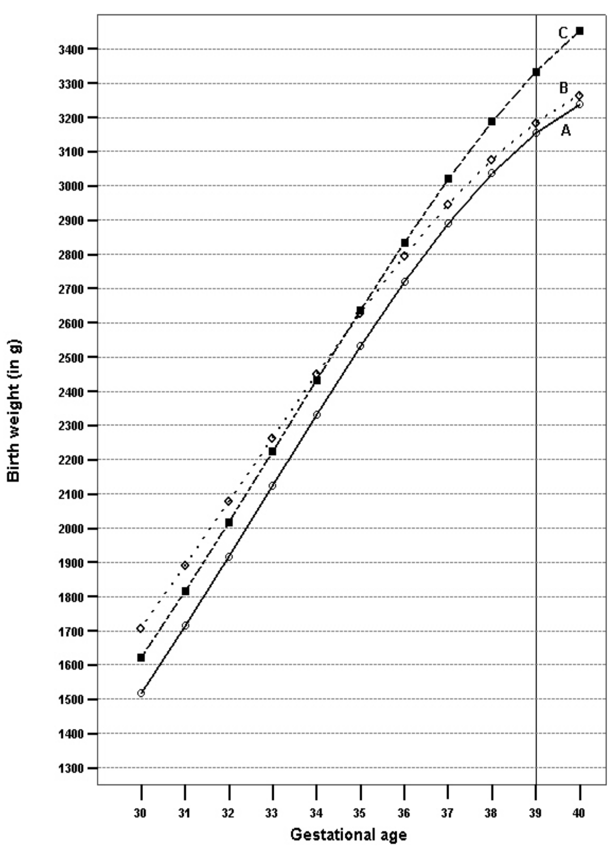

Figure 1

Intrauterine growth curve for singletons according to the three socioeconomic level hospitals, A, B and C. The reference line on 39 weeks indicates the approximate mean of the gestational age for singletons.

Discussion

The recording of twin births had never been the object of a nationwide survey in Brazil. While various studies are pointing to the fact that multiple births conceived using assisted reproduction technology (ART) have been increasing in the United States and Europe (Blondel & Kaminski, 2002; Reynolds et al., 2003; Warner et al., 2000), in Brazil no such data are available, except for studies referring to local analyses (Beiguelman et al., 1996; Colletto et al., 2001; Colletto, 2003; Colletto et al., 2003).

In the present study, the comparison among twin births from populations of different socioeconomic classes defined by the type of hospital where these children were born, points to some differences that may be linked to ART procedures. The gestational age was significantly lower in the population servicing the hospital with a better socioeconomic level where ART pregnancies occur more frequently, in accordance with the data of Lambalk and van Hoof (2001) on a Dutch nationwide survey of primiparous dizygotic twin deliveries, and Narine et al. in 2003.

On the other hand, the analysis of the population of lower socioeconomic level showed a significantly lower birthweight mean compared to the other hospitals for singleton births. The influence of socioeconomic level on birthweight is well known, as described by Victora et al. (1987) in Brazil, by Roder et al. (1997) in Australia, and by Luginaah et al. (1999) in Canada, so this finding was expected. However, for twins' birthweight, the results were quite different and the population of the higher socioeconomic levels behaved similarly to the population of the lowest level, presenting no statistical difference for the mean birthweight of twins.

https://doi.org/10.1375/twin.7.2.128 Published online by Cambridge University Press

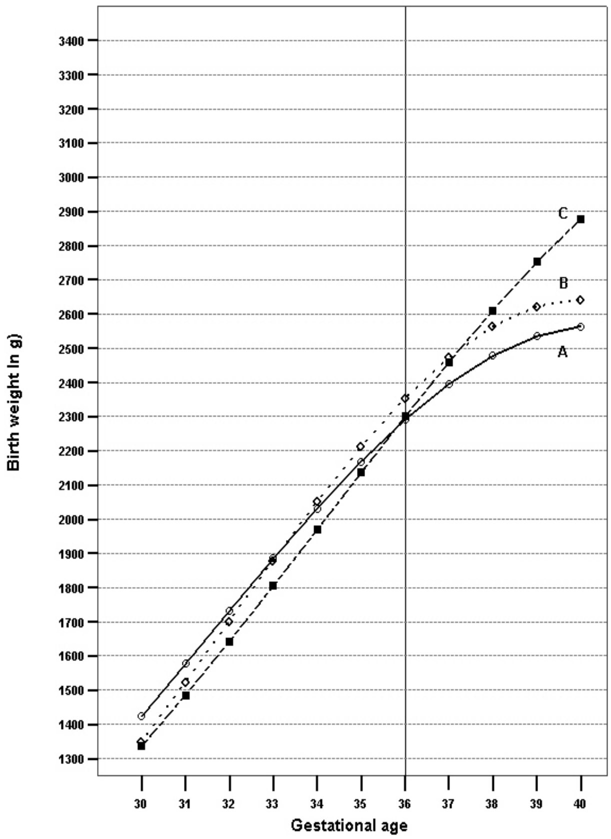

Figure 2

Intrauterine growth curve for twins according to the three socioeconomic level hospitals, A, B and C. The reference line on 36 weeks indicates the approximate mean of the gestational age for twins.

Within each hospital the type of birth did not interfere with the birthweight for singletons. However, for twins, the birthweight in CS was higher than normal birth at the three hospitals. Among twins, the higher gestational age found in CS than for normal birth can explain the difference in the birthweight of these children.

Nevertheless, when analyzing the twins' birthweight to primigravidae and multigravidae mothers, our data are in accordance with the literature (Lambalk & van Hoof, 2001; Narine et al., 2003). That is, the birthweight of twins from ART was lower than that for natural twins. Considering that the primigravidae mothers of twins would be the ones most frequently submitted to ART, while the multigravidae mothers would hardly do so, it was verified that the groups of patients from the hospitals of better socioeconomic level, where ART is a common procedure and the twin rate is very high (Colletto et al., 2003), showed significant differences between the mean birthweight of twins to primigravidae and those to multigravidae mothers, the former being the lowest. Besides, among the population of hospital C the frequency of primigravidae mothers of twins was much higher than the multigravidae, which is very unusual for a population born by natural conception (Revenis & Johnson-Robins, 1999).

The intrauterine curves constructed showed that the curve for the high socioeconomic level population was upward of those for the population of the other two hospitals at 39-week gestational age, according to the findings previously referred to regarding birthweight for singletons and socioeconomic status. However, when looking at the twins' curves at 36-week gestational age, the curves from the populations of the three hospitals were practically the same, meaning that the etiology of prematurity and/or low birthweight in twins may be essentially mechanical, compared to singletons, where it is generally related to outer factors (Gedda et al., 1981). Only after 38-weeks gestational age did the three curves become different, reaching higher values according to the socioeconomic levels. Another aspect to be pointed out was the high percentage of children born up to 37-weeks gestation in hospital C, which was different from the other two hospitals and also from data in the literature (Keith, 1994), which may be explained by the patterns of obstetric intervention in hospital C.

These results suggest that the use of ART in a subfertile population needs to be monitored in order to assess the appropriateness of intrauterine growth in different types of reproductive care, as well as to prevent premature deliveries and its possible complications, among which are respiratory distress syndrome, chronic lung disease or intracranial hemorrhage, leading to death or lifelong disabilitating conditions.

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https://doi.org/10.1375/twin.7.2.128 Published online by Cambridge University Press

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