

Differences in Anthropometric Measurements between Sudanese Newborn Twins and Singletons

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Twin pregnancies are associated with disturbed fetal growth and a higher risk of low birthweight (LBW), which is one of the most important determinants of perinatal morbidity and mortality in Africa. In this study, we compare anthropometric measurements in Sudanese twins and their mothers with singletons. *Methods:* In 1000 Sudanese mothers with singleton births and 30 mothers with twins, maternal (weight, height, mid-arm circumference) and 11 newborn anthropometric measurements were taken within 24 hours of delivery. Maternal education and socio-economic status were additionally recorded. *Results:* Mothers of twins had a significantly higher body weight ($p = .045$) and lean body mass ($p = .02$) after delivery, and were from higher social classes in general ($p = .014$). In addition to gestational age, twins displayed a statistically significant reduction in all anthropometric data, compared to singletons, mainly in terms of birthweight, chest and head circumference, whereas differences in triceps and subscapular skin fold thickness and ponderal index were distinctly lower. The LBW rate in twins was markedly higher than that in singletons (43.3% vs. 8.3%, $p < .001$). In 20 out of 30 twins (66.7%), Twin A weighed more than Twin B (difference (SD) of 443 (335) g), and in the remaining 10 cases (33.7%), the weight of Twin B was equal to or more than that of twin A (difference (SD) of 211 (240) g, $p = .039$). In unlike-sex pairs, the mean (SD) difference between Twins A and B in birthweight was 459 (481) g, which was distinctly higher, compared to same-sex pairs (boys, 180 (325) g and girls, 36 (413) g). *Conclusions:* Sudanese twins displayed significantly reduced anthropometric measurements compared to singletons, but to different degrees. Gender had a higher impact on birthweight in twins than in singletons.

Keywords: anthropometric measurements, pregnancy, twins, Africa

Twin pregnancies are associated with disturbed fetal growth. Previous studies show reduced twin fetal growth, compared to singletons, from at least as early

as 30 weeks gestation (Cohen et al., 1997; Min et al., 2000b; Voigt et al., 2001). These reports indicate that at a relatively early stage of pregnancy, the available resources of the mother are already depleted, and with increasing placental insufficiency during the last trimester, growth retardation escalates (Taylor et al., 1998; Voigt et al., 2004).

Birthweight is the most widely used indicator of growth. Growth retardation is associated with increased risk of perinatal morbidity and mortality, and there is accumulating evidence that abnormal fetal growth is associated with long-term consequences (Gluckman & Hanson, 2004). Low birthweight in twins appears to be the result of both prematurity and intrauterine growth restriction (Demarini et al., 2006). The use of weight alone does not provide information on body composition, which allows assessment of the quality of growth, such as extent of fat, protein and mineral deposition. To evaluate these parameters, special techniques (such as dual energy X ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA)) have been developed (Pietrobelli et al., 1998). However, these techniques are not widely available, especially in Africa, and simple anthropometric measurements, such as skin fold thickness and ponderal index (PI), applied to assess body composition, show excellent correlation with DXA and BIA data (Dung et al., 2007; Koo et al., 2004).

In Africa, low birthweight (LBW; < 2500 g) is the strongest determinant of infant morbidity and mortality, and may result in long-term physical and intellectual impairment (Mokhachane et al., 2006; Pietrobelli et al., 1998). In developing countries, LBW is common in twins. Okogbo and Familusi, 1997 reported a LBW rate of 53.9% among twins in Nigeria, which was distinctly higher than the incidence of 11.8% among singletons. However,

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gestational age birthweight is not the only factor that is reduced in twins. This study aimed to compare different anthropometric measurements between newborn twins and singletons in Africa, and determine the influence of maternal anthropometry as well as maternal education and socio-economic status on newborn anthropometric measurements.

Materials and Methods

Patients

The study was conducted during a one-year period, and anthropometric measurements taken from 30 mothers with multiple pregnancies and their newborns at the Soba University Hospital in Khartoum, Sudan. Measurements obtained from the twins were compared with those from 1000 mothers with singleton pregnancies from the same department, as described previously (Elshibly and Schmalisch, 2008a).

Mothers were recruited from a large inner urban area of Khartoum with wide differences in the socio-economic status. The three social classes were determined by the area of residence. In this study, mothers sure of the last date of their menstrual period were included, while those who were unsure of their dates or had their pregnancy complicated by diabetes mellitus were excluded from the study.

The study was approved by the Department of Pediatrics of the University of Khartoum, and consent was obtained from all mothers.

Protocol

To exclude inter-observer variations, measurements were taken within 24 hours of birth by one investigator (Elshibly) in the postnatal wards. Newborn measurements included birthweight, head, chest, mid arm, mid thigh, and abdominal circumference. Furthermore, babies' supine crown heel, crown rump and upper limb lengths were measured, as well as triceps and subscapular skinfold thicknesses. The ponderal index (PI) was calculated as follows:

$$PI = 100 \cdot \frac{BW}{SL^3}$$

where BW is the birthweight in g and SL is the supine length in cm. Maternal anthropometry parameters investigated included weight, height and mid-upper arm circumferences (MUAC). Using maternal weight and height, the body mass index (BMI) was calculated as follows:

$$BMI = \frac{MW}{MH^2}$$

where MW is the maternal weight in kg and MH is the maternal height in cm. Lean body mass (LBM) was calculated as follows:

$$LBM = 1.07 \cdot MW - 148 \cdot \frac{MW}{MH^2}$$

where MW is the maternal weight in kg and MH is the maternal height in cm.

Equipment

Babies' weights were measured using a standard scale (Atom, Japan) to the nearest 10 grams, while mothers' weights were measured with a standard scale to the nearest 100 grams. The mothers' heights were measured with a standard scale for height to the nearest millimeter. Babies' supine crown rump lengths were measured using an infantometer (Atom, Japan) to the nearest millimeter. Upper limb length was measured from the tip of the acromion process of the humerus bone to the most distal skin crease close to the hand. To minimize intra-observer variability, all circumferences were estimated with an inelastic tape to the nearest millimeter. Skin fold thicknesses were measured with a Skin fold Caliper (Holtain, Dyfed, UK) to the nearest millimeter.

Statistics

Results are presented as mean (SD) in the text, and as means with 95% confidence interval (CI) in the figures. Unless otherwise stated, the statistical significance of differences between mothers with singletons and twins and their newborns, as well as between twins A and B was investigated using the paired or unpaired student *t* test or χ^2 test, as appropriate. The relationships between birthweight, parity and gender were investigated by multivariate analysis of variance (MANOVA), considering maternal age and anthropometry as confounders. All statistical analyses were performed using the software STATGRAPHICS Centurion (Version 15, Statpoint Inc. Herndon, Virginia, USA). Statistical significance was defined as $p < .05$.

Results

Maternal Measurements

Descriptive statistics of maternal anthropometric measurements are presented in Table 1. Compared to mothers of singletons, those giving birth to twins had babies with a higher body weight of about 4.8 kg ($p = .045$) and a significantly higher lean body mass (46.3 vs. 44.2, $p = .02$) at delivery. There were no statistically significant differences in terms of age, height, MUAC and BMI.

The number of first-born twins (5; 17%) was significantly lower ($p = .043$) than that of first born singletons (370; 37%). The parity of multiparous mothers ranged between 2 and 14 in singletons, and 2 and 7 in twins. Moreover, the relationship between parity and birthweight was different between singletons and twins. As shown in Figure 1, in singletons with increasing parity, birth weight was markedly higher ($p < .001$), with no statistically significant differences between boys and girls. In contrast, at birth, significant sex differences were observed in twins ($p = .02$). In these cases, birthweight increased with

Table 1
Comparison of Ages and Anthropometric Parameters of Mothers With Singleton Babies and Twins

	Mothers with singleton babies (N = 1000)	Mothers with twins (N = 30)	P value
Age (years)	26.9 (5.4)	28.2 (4.1)	.200
Weight (kg)	65.2 (13.0)	70.0 (11.1)	.045
Height (cm)	159.6 (6.2)	160.8 (6.8)	.319
Mid arm circumference (cm)	26.9 (3.9)	27.0 (3.4)	.893
Body mass index (kg/m ²)	25.5 (4.8)	27.1 (4.1)	.085
Lean body mass	44.2 (4.9)	46.3 (4.9)	.023

Note: Means with SD in brackets, significant *p* values are presented in bold.

increasing parity in girls, while that of boys remained constant.

Among mothers of singletons and twins, a considerable number of women had ≤ 8 years education (38.0% and 26.7%), most had high school education (48.7% and 53.3%), and 13.3% and 20% had university education, respectively. There were no statistically significant differences in terms of years of education between the two groups of mothers. However, the level of social class was significantly higher (*p* = .014) in mothers of twins, compared to mothers of singletons, as shown in Figure 2.

Comparison of Anthropometric Measurements Between Singletons and Twins

The gestational ages and anthropometric measurements of singletons and twins are compared in Table 2. The duration of gestation was a mean of 1.7 weeks shorter, and birthweight was approximately 614 g lower for twins. Additionally, twins displayed reduced anthropometric measurements, compared to singletons. As shown in Table 2, the largest differences were observed in birthweight, chest and head circumfer-

ence, while differences in the triceps and subscapular skinfold thickness and the ponderal index were distinctly lower.

The incidence of LBW in twins was nearly 5 times higher and the SGA rate nearly 3 times higher, compared to singletons (Table 3). In both the singletons and twin groups, there were no statistically significant differences in the LBW and SGA incidence between boys and girls.

Sex distribution depended on the birth order, as shown in Figure 3. While 51.4% of babies were boys among singletons, 63.7% of boys were recorded as the first twin (Twin A) and only 36.7% of boys as the second twin (Twin B). The sex differences between the first and second twins were statistically significant (*p* = .039).

Effects of Twin Order and Sex on Anthropometric Measurements

A comparison of the anthropometric measurements between the first and the second twins is shown in Table 4. In addition to the sex differences between the first and second twins, we observed that the second twin had statistically significant lower chest circumference, birthweight, limb length, PI, and head circumference. No statistically significant differences were evident for all other anthropometric measurements.

In 20 out of 30 twins (66.7%), Twin A weighed more than B (difference in birthweight of 443 (335) g) and in the 10 remaining twins (33.7%), the weight of Twin B was equal to or more than that of Twin A (difference in BW of 211 (240) g, a difference that was statistically significant (*p* = .039).

In addition to birth order, birthweight depended on sex, as shown in Table 5. Twenty twin pairs were of the same sex (10 pairs of boys, 10 pairs of girls) and 10 pairs were of different sexes (9 cases of the first baby being a boy, 1 case of the first being a girl). As shown in Table 5, in unlike-sex pairs, the differences in birthweight were 459 g and distinctly higher, compared to same-sex pairs. We have to consider that in our study,

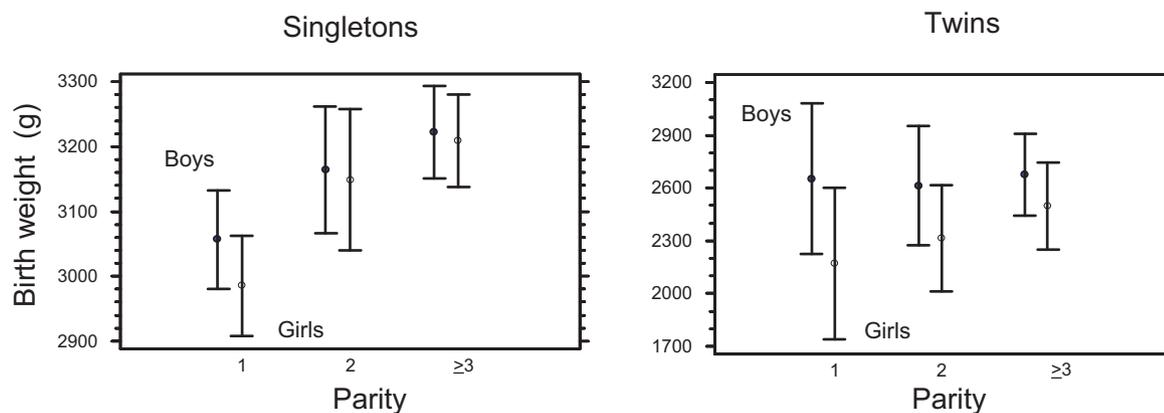


Figure 1
Increase in birth weight with increasing parity in singletons (left) and twins (right) (Group mean values for boys and girls with 95% CI are presented).

Table 2

Comparison of Gestational Age and Anthropometric Parameters of Singleton Newborns With Those of Twins Ordered According to Statistical Significance

	Singleton (<i>N</i> = 1000)	Twins (<i>N</i> = 60)	<i>t</i> value	<i>P</i> value
Birthweight (g)	3131.7 (538.9)	2518.2 (487.3)	8.61	<.0001
Chest circumference (cm)	31.7 (2.4)	29.2 (2.5)	7.72	<.0001
Head circumference (cm)	34.4 (1.7)	32.8 (1.6)	7.17	<.0001
Gestational age (weeks)	39.1 (1.8)	37.4 (2.1)	6.94	<.0001
Abdominal circumference (cm)	28.2 (2.7)	25.7 (2.5)	6.88	<.0001
Crown rump length (cm)	33.6 (2.2)	31.5 (3.4)	6.84	<.0001
Mid arm circumference (cm)	10.0 (1.1)	9.0 (1.0)	6.81	<.0001
Mid thigh circumference (cm)	15.0 (1.7)	13.6 (1.5)	6.22	<.0001
Limb length (cm)	15.0 (1.0)	14.2 (.9)	5.85	<.0001
Supine length (cm)	49.3 (2.9)	47.2 (3.3)	5.58	<.0001
Triceps skin fold thickness (mm)	.82 (.21)	.74 (.17)	2.95	.003
Sub scapular skin fold thickness (mm)	.83 (.24)	.75 (.16)	2.58	.009
Ponderal index (g/cm ³)	2.61 (.45)	2.42 (.54)	2.56	.010

Note: Presented as means with *SD* in brackets, all *p* values were statistically significant.

in 9/10 (90%) unlike-sex pairs, the first born was a boy and the second was a girl. Nevertheless, in singletons, the difference in birthweight between boys and girls was 34.9 g, while the difference in unlike-sex pairs was more than 10-fold higher.

Discussion

Anthropometric measurements of twins may contribute to our knowledge of the physiological changes occurring during normal and abnormal fetal growth, and facilitate the identification of newborns at risk. Our study showed that twins have a significantly shorter duration of gestation and lower anthropometric measurements, compared to singletons. Furthermore, marked differences were evident between the first and second twins in terms of gender, chest circumference, birthweight, limb length, PI, and head circumference. Compared to singletons, gender had a higher impact on birthweight in twins. However, there is no general agreement on this issue in the literature.

In singletons, parity is one of the most important maternal factors affecting birthweight (Elshibly & Schmalisch, 2008b). In twins, this relationship was only evident in girls. This finding is inconsistent with the results of Riese et al., 2003, who showed that maternal anthropometric variables, including parity, which act as statistically significant predictors of twin outcome parity, are more predictive for male than female twins.

With the exception of maternal weight at birth and socio-economic status, no differences were evident between the mothers of singletons and twins. This finding is consistent with data from a recent study in Korea (Lee et al., 2007). However, in mothers of twins with > 25% birthweight discordance, remarkable fluctuations were observed in weight gain during the gestation period, compared with mothers of twins with < 25% weight discordance, who displayed a constant increase in maternal weight.

Indian investigators found that the incidence of twin births was higher among primipara mothers and those ranging between 21 and 25 years of age (Jaya et al., 1995). In our study, twin pregnancies were more common among multipara women (mean of three deliveries), with no significant age differences between mothers of singletons and twins. However, our twin mothers were from a higher social class, and had higher weights and leaner body mass than singleton mothers. This may be attributed to better nutrition in mothers from a higher social class, although it is generally accepted that a genetic role is operative in twin pregnancies, as evident from the familial tendency to give birth to twins. Mothers of twins in our study did not receive assisted reproductive technology, which is reported to account for the disproportionate number of low birthweights and/or premature infants in primigravidae at a higher socio-economic level (Colletto et al., 2004).

Table 3

Comparison of LBW and SGA Incidence Between Singletons and Twins

	Singleton (<i>N</i> = 1000)	Twins (<i>N</i> = 60)	<i>p</i> value
LBW			
Boys	9.14%	33.3%	<i>p</i> < .001
Girls	7.4%	53.3%	<i>p</i> < .001
Both genders	8.3%	43.3%	<i>p</i> < .001
SGA			
Boys	16.1%	43.3%	<i>p</i> < .001
Girls	16.5%	46.6%	<i>p</i> < .001
Both genders	16.3%	44.9%	<i>p</i> < .001

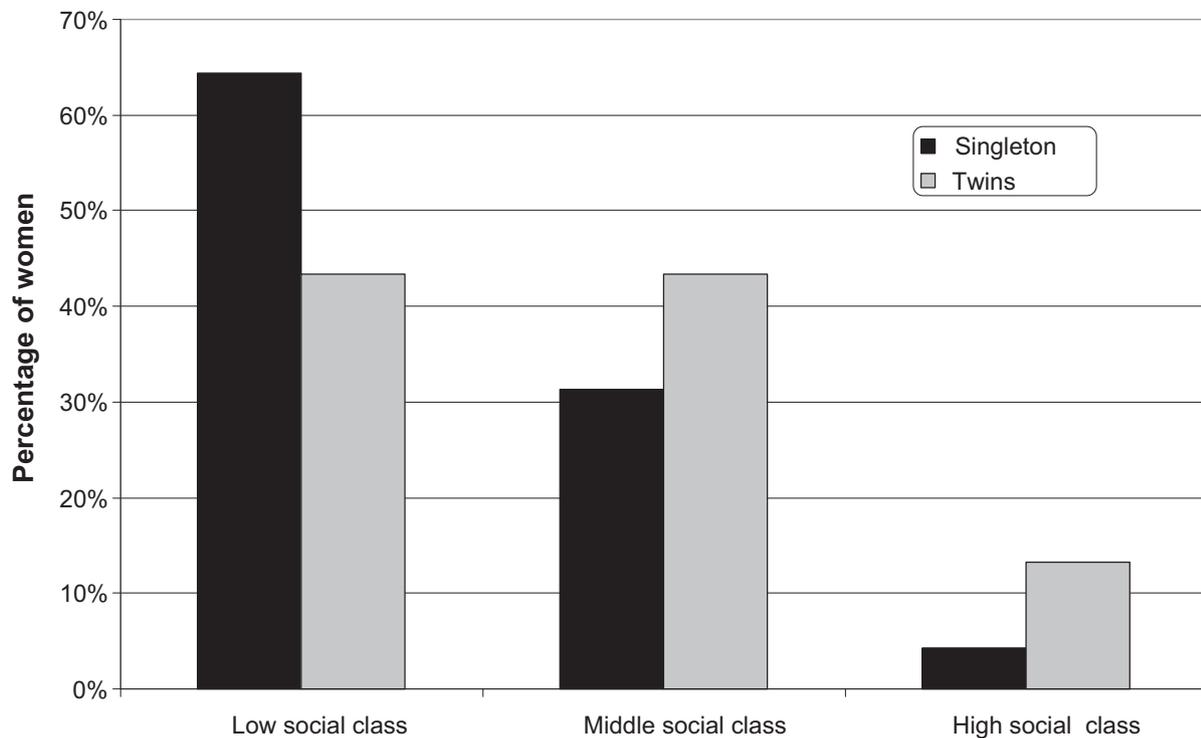


Figure 2

Social class distribution of mothers with a singleton babies and mothers with twins. We observe a significant shift ($p = .014$) to a higher social class in mothers with twins.

While intrauterine growth of twins is generally slower than that of singletons (Liu & Blair, 2002), Min and colleagues (Min et al., 2000a) suggest that from 30 weeks of gestation onwards, the growth patterns of well grown twins and singletons may not be significantly different. Demarini et al., 2006 showed that in normal neonates, body composition with respect to bone, fat and lean mass components are similar, regardless whether they are products of single-

ton or twin pregnancies. This does not seem to be the case in our study twins, as all anthropometric measurements were significantly lower in twins, and our results conform with those of Mexican (Ticona et al., 2006) and Norwegian (Glinianaia et al., 2000) workers showing that twin intrauterine growth differs from that of singleton newborns and specific charts should be used to monitor growth of twins.

Table 4

Comparison of Anthropometric Parameters of Twins A and B Ordered According Their Statistical Significance

	First twin (N = 30)	Second twin (N = 30)	P value
Chest circumference (cm)	29.7 (2.3)	28.7 (2.5)	.006
Birthweight (g)	2631 (524)	2406 (427)	.008
Limb length (cm)	14.4 (1.0)	14.0 (.8)	.017
Ponderal index (g/cm ³)	2.51 (.60)	2.33 (.47)	.018¹
Head circumference (cm)	33.1 (1.6)	32.5 (1.6)	.041
Mid-thigh circumference (cm)	13.8 (1.3)	13.3 (1.6)	.112
Abdominal circumference (cm)	26.0 (2.4)	25.5 (2.7)	.239
Mid arm circumference (cm)	9.1 (.9)	8.9 (1.0)	.251
Supine length (cm)	47.3 (3.8)	47.0 (2.8)	.294
Crown rump length (cm)	31.9 (2.0)	31.1 (4.5)	.464
Subscapular skinfold thickness (mm)	.77 (.13)	.73 (.19)	.628
Triceps skin fold thickness (mm)	.74 (.14)	.74 (.19)	.974

Note: Means with SD in brackets, significant p values are presented in bold

¹Wilcoxon test due to non-normal distribution

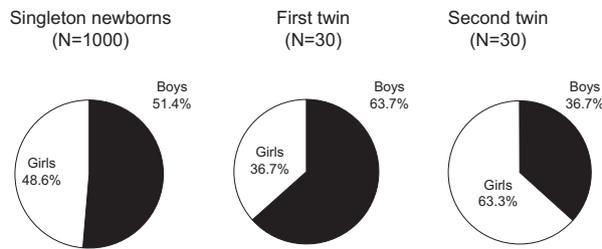


Figure 3
Sex distribution in singleton newborns and twins.

The birth lengths of twins were shorter than those of singletons, but these differences were smaller, compared to those in birthweight (Dung et al., 2007). A study in Japan revealed no differences between chest and head circumference measurements between twins and singletons (Ooki & Yokoyama, 2003). In contrast, these parameters were significantly different in our twins. Buckler and co-workers (Buckler & Green, 2004) showed no length/height deficits in twins, but smaller head circumferences, compared to singletons. Ong et al., 2002 observed that the growth in the abdominal circumference of twins followed that of singletons up to the 32nd week, after which it markedly declined. Femur length growths were comparable, but from mid to early third trimester, the biparietal diameters of twin babies were larger than those of singletons. Socol and colleagues (Socol et al., 1984) demonstrated that both abdominal circumference and biparietal diameter growth slowed in the third trimester. However, postnatally, the head circumference of twins was similar to that of singletons. They attributed this discrepancy to dolichocephaly due to uterine crowding. In our study, the head circumference of twins was significantly lower than that of singletons at birth.

In our study the birthweight difference depended on the genders of the twins. In unlike-sex pairs, the mean difference in birthweight was distinctly higher (459 g), compared to same-sex twins (boys 180g, girls 36g) and compared to different sexes in singletons (34.9 g). No statistically significant differences in gestational age between unlike-sex and same-sex twins

were evident. In a distinct larger study group ($N = 1929$), Loos et al., 2001 showed that in unlike-sex pairs, the female twin prolongs the duration of pregnancy for her brother, resulting in higher birthweights than those of same-sex males.

The first-born baby was heavier than the second born in 66.7% of cases, and the difference between mean birthweights in the case of Twin A > B was significantly greater, compared to that when Twin A < B (443 g vs. 211 g, $p = .039$). Our results agree well with those of Jaya et al. (Jaya et al., 1995), who found that Twin A was heavier than Twin B in 44.78% of twin pairs and their mean birthweight difference was 438 g, while Twin B was heavier than Twin A in 38.31% of twin pairs with a mean birthweight difference of 291 g. Some workers observed that female birthweight was influenced by the presence of a male co-twin. The authors suggested that this observation may be biologically significant, and should be closely followed up with studies on dizygotic unlike-sexed and dizygotic like-sexed females with respect to hormone-sensitive disorders (Glinianaia et al., 1998). We observed a statistically significant difference between the weights of boy and girl twins, which highlights the existence of gender difference even in twin pregnancies, irrespective of the twin order. The importance of fetal gender has also been reported by Essel and Opai-Tetteh, 1994, who found that in unlike-sex twins, males were heavier, irrespective of birth order. A significant positive correlation was observed with singleton baby variables, specifically, the higher the maternal BMI, the higher the newborn's BMI, weight, length, and gestational order. However, we observed no significant correlation between maternal BMI and any of these variables in twins (Colletto & Segre, 2005). All covariates analyzed markedly influenced the birthweights of twins, except the sex of the co-twin and modes of conception and delivery (Gielen et al., 2007).

Among dizygotic twins, birthweight is not affected by the sex of the co-twin. Therefore, birthweight differences in dizygotic pairs have to be ascribed to the general effects of sex and birth order. No effects are specific for dizygotic pairs only (Orlebeke et al., 1993). A study based in Mexico (Ticona et al., 2006) showed that opposite-sex twins grew consistently

Table 5
Effects of Twin Order and Sex on Birthweight

	Birthweight Twin A	Birthweight Twin B	Difference with 95% CI	<i>p</i> value
Pairs of boys ($N = 10$)	2744 (476)g	2564 (384)g	180 g (–53 g to 413 g)	$p = .115$
Unlike sex pairs ($N = 10$)	2708 (699)g	2249 (537)g	459 g (115 g to 803 g)	$p = .015$
Pairs of girls ($N = 10$)	2440 (327)g	2404 (330)g	36 g (–260 g to 332 g)	$p = .789$

Note: significant *p* values are presented in bold.

faster than like-sex twins (Liu and Blair, 2002). Analysis of 2491 twins revealed longer gestation periods and faster growth rates of fetuses of both sexes in unlike-twin pairs (Luke et al., 2005).

In conclusion, Sudanese twins display both similar and different features to those described in the literature. Our study discloses a significant reduction in all measured anthropometric parameters in twins compared to singletons, but to different degrees. In twins, gender has a higher impact on birthweight than in singletons. The high LBW rate in twins (43.3%) compared to that in singletons (8.3%) indicates increased risk of perinatal morbidity and mortality in twins, particularly in a developing country.

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