

Biological and social traits associated with twinning among Caucasoids and Negroids

Bernardo Beiguelman¹, Carla Franchi-Pinto² and Luis Alberto Magna¹

ABSTRACT

The records of Caucasoid (589) and Negroid (142) mothers of twins, and of a control group of mothers of singletons (1267 Caucasoids and 248 Negroids) born from 1984 to 1993 in the largest maternity hospital of Campinas, SP, Brazil (Maternidade de Campinas) were investigated for the following traits: type of hospital care, marital status, maternal age, occurrence of labor, type of delivery, parity, previous spontaneous abortions, gestational age, birth weight and birth length of twins and singletons. The main conclusions were: 1) the proportion of women whose hospital and medical care expenses were covered by welfare program or who were indigent was significantly higher among Negroids than among Caucasoids, but twinning was not associated with social class; 2) the proportion of married women among Caucasoids was higher than among Negroids, and a greater proportion of Caucasoid mothers of twin births were married as compared to mothers of singletons; 3) Caucasoids and Negroids did not differ concerning mean maternal age, occurrence of labor, type of delivery, rate of previous spontaneous abortions, and mean gestational age; 4) when compared to women who bore singletons, mothers of twin births were, on the average, almost two years older, and had a lower proportion of labor, a higher proportion of cesarean sections, and a higher abortion rate, while the twins had a lower mean gestational age (three weeks) than singletons; 5) parity among Caucasoids was lower than among Negroids, and in both races mothers of twin births had a higher parity than mothers of singletons; 6) twins had a lower mean weight and height at birth than singletons, males were slightly heavier than females, and Negroids were slightly lighter at birth than Caucasoids.

INTRODUCTION

Maternal race is included among the several factors that influence twinning incidence, which is highest among Negroids, followed by Caucasoids, and lowest among Mongoloids (Imaizumi and Inouye, 1979; Nylander, 1981; Azubuike, 1982; Khoury and Erikson, 1983; Akanlawon and Ejiwunmi, 1986; James, 1986; Marinho *et al.*, 1986; Beiguelman and Villarroel-Herrera, 1993; Pollard, 1996). Therefore, we decided to compare

Caucasoids and Negroids who belong to the same multiracial population with respect to some biological and social traits considered to be associated with twinning.

SUBJECTS AND METHODS

The Caucasoid (589) and Negroid (142) mothers of twins born from 1984 to 1993 were investigated from the records of the largest maternity hospital of Campinas, SP, Brazil (Maternidade de Campinas). These deliveries referred not only to live births but also to stillborn children, except fetuses with less than 500 g. These fetuses were excluded from this study and classified as abortions since this fetal weight

¹ Departamento de Genética Médica, Faculdade de Ciências Médicas, UNICAMP, Caixa Postal 6111, 13081-970 Campinas, SP, Brasil. Send correspondence to B.B.

² Serviço de Genética Médica da Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brasil.

corresponds to a gestational age between 20 and 22 weeks, as well as to a 25-cm fetal length (Belitzki *et al.*, 1978). A group of 1515 mothers of singletons born in the same period and in the same hospital as the twins (1267 Caucasoids and 248 Negroids) were used for control.

The following traits were analyzed: type of care in the hospital (private clinic, welfare, indigent), marital status of the mothers, maternal age, occurrence of labor, type of delivery, parity (previous deliveries), previous spontaneous abortions, gestational age, and birth weight and length of twins and singletons. Since the routinely registered records were not always complete, the number of cases varied slightly for the different traits under analysis. Only the borderline cases of chi-square with one degree of freedom were corrected for continuity (Yates correction). The degrees of freedom of chi-square were shown only when they were greater than one.

RESULTS AND DISCUSSION

Type of hospital care

The proportion of women whose hospital and medical care expenses were covered by welfare program or who were indigent was significantly higher among Negroids than among Caucasoids, both when they gave births to twins ($\chi^2 = 14.56$, $P < 0.001$) and singletons ($\chi^2 = 41.51$, $P < 0.001$) (Table I). However, mothers of twins and controls did not differ significantly concerning within-race comparisons of type of care ($\chi^2 = 0.98$, $0.30 < P < 0.50$ for Caucasoids; $\chi^2 = 2.00$, $0.10 < P < 0.20$ for Negroids).

Table I - Percentage of Caucasoid and Negroid mothers of twin births and controls according to the type of care received in the hospital.

Sample	Race	No.	Private clinic	Welfare	Indigent
Twins	Caucasoid	588	44.2	54.4	1.4
	Negroid	141	27.0	70.2	2.8
Controls	Caucasoid	1264	43.1	56.0	0.9
	Negroid	248	21.4	76.6	2.0

Since the presence of women in the private clinic is an indication of their standard of life, it allows an indirect evaluation of their social class. As no significant differences within each racial group were found when mothers of twins and controls were compared, concerning the proportion in the private clinic, our results agree with the Scottish data of Campbell *et al.* (1974) and the British data of Murphy and Botting

(1989), who could not observe an association between social class and twin birth rate. However, they are in disagreement with those of Myriantopoulos (1970), who found a higher twinning rate in higher social classes in the United States, and differs from those of Smith (1974), who observed the opposite in Scotland. Our observations are also partially divergent from those of Nylander (1981), who detected no association between twinning rate and social class in Scotland, but noted a higher dizygotic twinning rate among women belonging to lower social classes in Nigeria.

Marital status

The proportion of married women was significantly higher among Caucasoids than among Negroids (Table II), both among mothers of twins ($\chi^2 = 27.85$, $P < 0.001$) and controls ($\chi^2 = 18.67$, $P < 0.001$). The proportion of married women among the mothers of twins was also significantly higher than that observed in the controls ($\chi^2 = 4.76$, $P < 0.05$) but this excess was only due to the Caucasoid mothers ($\chi^2 = 9.0$, $P < 0.01$), since the proportions of married mothers of twins and singletons did not differ among Negroids ($\chi^2 = 0.02$, $0.80 < P < 0.90$).

Table II - Percentage of married women among Caucasoid and Negroid mothers of twin births and controls.

Sample	Race	No.	Married women
Twins	Caucasoid	569	86.1
	Negroid	140	67.1
Controls	Caucasoid	1248	80.3
	Negroid	242	67.8

Several authors have detected a significantly higher twinning rate in illegitimate maternities than in legitimate ones (Eriksson and Fellman, 1967; James, 1981; Nylander, 1981). This observation has been interpreted as evidence that women prone to twins are also more fecundable, and consequently more likely to become pregnant outside marriage, with an accompanying higher twinning rate due to polyovulation. Murphy and Seagroatt (1992) confirmed that the twinning rate in Great Britain was consistently higher among unwed women until 1989, when this situation reversed, as a consequence of an increasing tendency of twinning among married women since the seventies. They concluded that this tendency was due to the fact that ovulation induction and techniques of assisted conception are apparently more available to married women.

The North-American data of Myriantopoulos (1970), concerning Caucasoid and Negroid pregnancies, differed from the British data, since in both racial groups the proportion of single mothers of twins was lower than the proportion of single mothers of the study population. When examined by age of mothers, the percentage of illegitimate twin births among all births was slightly but not significantly higher than the legitimate ones for all age groups. At any rate, in the Myriantopoulos data (1970), the number of illegitimate twin births among Caucasoid mothers was small (11).

Therefore, the data in Table II are in opposition to most data in the pertinent literature, and we cannot explain why the proportion of married women among the Brazilian Caucasoid mothers of twin births is significantly higher than that observed among controls.

Maternal age

The mean age in years of the Caucasoid (26.78 ± 5.71) and Negroid (27.18 ± 6.34) women who bore twins did not differ significantly ($t = 0.687$, $0.40 < P < 0.50$), the same being true for Caucasoid (25.02 ± 5.86) and Negroid (24.76 ± 6.59) mothers of singletons ($t = 0.578$, $0.50 < P < 0.60$). Therefore, the mean maternal ages for mothers of twins and singletons in southeastern Brazil may be estimated respectively as 26.82 ± 6.02 and 24.98 ± 5.99 , which are significantly different ($t = 6.797$, $P < 0.001$).

These results confirm most published results, which have shown that the mean age of mothers of twin births is significantly higher than that of mothers of singletons (Chen *et al.*, 1987; Bertranpetit and Marin, 1988; Bonnelykke, 1990; *inter alia*). Furthermore, they agree with the observation of Beiguelman and Villarroel-Herrera (1993) that the lower mean maternal age exhibited in the past by Negroid women in southeastern Brazil is not confirmed at present. At least in Campinas, Caucasoid and Negroid women have converged to the same mean maternal age.

Occurrence of labor

In spite of the higher percentage of labor observed among the Negroid maternities (Table III), Caucasoid and Negroid mothers of twin births did not differ significantly concerning this trait ($\chi^2 = 2.69$, $0.10 < P < 0.20$), the same being true for mothers of singletons ($\chi^2 = 1.33$, $0.20 < P < 0.30$). However, the proportion of labor among the mothers of twins (70.3%) was significantly lower than that observed in controls (78.2%) ($\chi^2 = 16.24$, $P < 0.001$), probably because in Brazil

cesarean sections are more frequently recommended for women bearing twins, independent of the gestational age. Unfortunately, we have not been able to find references comparing the frequency of labor for mothers of twin births.

Table III - Percentage of labor among Caucasoid and Negroid mothers of twin births and controls.

Sample	Race	No.	Labor
Twins	Caucasoid	588	69.0
	Negroid	142	76.1
	Total	730	70.3
Controls	Caucasoid	1267	77.7
	Negroid	247	81.0
	Total	1514	78.2

Type of delivery

No racial differences concerning the type of delivery could be observed either among the mothers of twins ($\chi^2 = 3.49$, $0.05 < P < 0.10$) or controls ($\chi^2 = 3.75$, $0.05 < P < 0.10$), but the proportion of cesarean sections was significantly higher ($\chi^2 = 33.34$, $P < 0.001$) among the women who bore twins (60.6%) when they were compared to those who gave birth to singletons (47.6%) (Table IV).

Table IV - Percentage of cesarean sections among Caucasoid and Negroid women who bore twins and single births.

Sample	Race	No.	Cesarean
Twins	Caucasoid	583	62.3
	Negroid	138	53.6
Controls	Caucasoid	1264	48.7
	Negroid	248	41.9

The statistics of cesarean sections among women who bear twins varies in different countries and even in the same country, since this modality of birth depends not only on the gestational age of the fetuses and the detection of maternal and/or fetal complications, but also on the medical team, the maternity hospital and the clients' will. Thus, for instance, Papiernik *et al.* (1985) found 40% of cesarean sections among mothers of twins in Paris; Olofsson and Rydhström (1985) mentioned 24.2% of these deliveries from 1973 to 1982 in Sweden, while in Italy Pachi *et al.* (1994) indicated 71.6%, a proportion which is practically twice that observed by Cannatelli *et al.* (1994) in the same country (36.8%).

Our data also show that cesarean sections are more frequent among mothers of twins than among mothers of singletons. However, we found that among the women who gave birth to singletons, the frequency of cesarean sections was as high as 47.6%, in spite of the elevated frequency of labor (78.2%) (Table III). Obviously such a high frequency of cesarean sections is not expected in public Brazilian hospitals. In fact, in a university hospital in Curitiba, PR, Brazil, Pilotto *et al.* (1993) found 28.4% cesareans among 1045 mothers of single births, a proportion that is nearer to that observed in the United States among mothers of singletons (20%) (Rezende, 1988).

Parity

Table V shows that parity among Caucasoids was significantly lower than among Negroids, both among mothers of twins ($\chi^2 = 30.04$, d.f.= 8, $P < 0.001$) and controls ($\chi^2 = 19.82$, d.f.= 7, $P < 0.01$). On the other hand, both Caucasoid ($\chi^2 = 62.29$, d.f.= 8, $P < 0.001$) and Negroid ($\chi^2 = 27.54$, d.f.= 6, $P < 0.001$) mothers of twin births exhibited a significantly higher parity than the mothers of singletons of corresponding racial groups. It is well known that twin-prone women are more easily fecundable, their average time until conception being estimated to be 2.2 months shorter than that of mothers of singletons (Allen and Schachter, 1971). However, the higher parity of Negroids in relation to Caucasoid women cannot be attributed to a fertility advantage of Negroids, since we cannot exclude the possibility of a lower proportion of users of oral contraceptives among them, as often occurs among people who belong to low socio-economic classes.

Parity and maternal age are known to be positively correlated, both being correlated with twinning. Therefore, one might conclude that the increase of twin birth frequency according to maternal age would merely reflect parity or vice-versa. However, most authors agree that the effects of parity and maternal age on twinning are independent, not additive, and due to an increase in dizygotic twinning rate only (Bulmer, 1959; Shipley *et al.*, 1967; Elwood, 1978; Nylander, 1981; Khoury and Erikson, 1983; Chen *et al.*, 1987; Bertranpetit and Marin, 1988; Picard *et al.*, 1989; Allen and Parisi, 1990; Imaizumi, 1992).

Spontaneous abortions

Caucasoid and Negroid mothers of twin births do not differ significantly in number of previous spontaneous abortions

($\chi^2 = 3.94$, d.f.= 3, $0.20 < P < 0.30$), the same being true for the mothers of singletons ($\chi^2 = 1.68$, d.f.= 3, $0.50 < P < 0.70$) (Table IV).

The proportions of spontaneous abortions in previous pregnancies were also similar for the two races, allowing us to estimate the combined abortion rates for mothers of twin births and singletons as $8.36 \pm 0.63\%$ and $6.24 \pm 0.43\%$, respectively. These proportions differ significantly ($\chi^2 = 7.55$, $P < 0.01$). This difference may indicate that the higher spontaneous abortion rate exhibited by mothers of twin births as compared to singletons is a consequence of the twinning proneness of the former, since twins are more easily aborted than singletons.

Our data differ from those of Hémon *et al.* (1979), who found that mothers of twin births and singletons had similar abortion rates. Moreover, the rates these authors observed in France are higher (about 14.5%) than those pointed out in Table VI. The French data also differ from those of Freire-Maia and Krieger (1963), and Krieger (1972) for other Brazilian

Table V - Percentage of Caucasoid and Negroid mothers of twin births and controls according to parity.

Previous deliveries	Twins		Controls	
	Caucasoid (589)	Negroid (142)	Caucasoid (1267)	Negroid (248)
0	34.6	28.2	50.0	46.0
1	31.4	28.2	27.0	21.8
2	17.3	12.0	14.3	17.3
3	9.0	10.6	5.4	6.5
4	5.4	10.6	1.3	4.0
5	0.7	2.8	1.0	2.8
6	0.7	2.8	0.2	0.4
7	0.3	2.8	0.5	0.4
8	0.3	1.4	0.1	-
9	-	0.7	0.1	0.4
10	0.2	-	-	0.4
11	-	-	0.1	-
Mean \pm SD	1.29 \pm 1.41	1.94 \pm 2.06	0.89 \pm 1.24	1.19 \pm 1.58

Table VI - Percentage of Caucasoid and Negroid mothers of twin births and controls according to the number of spontaneous abortions and the abortion rate.

Sample	Race	No.	0	1	2	3	4	Abortion Rate (%)
Twins	Caucasoid	589	84.6	11.5	2.7	1.0	0.2	8.38 \pm 0.73
	Negroid	142	78.9	17.6	2.1	1.4	-	8.15 \pm 1.28
Controls	Caucasoid	1267	88.6	8.4	2.4	0.5	0.1	6.20 \pm 0.48
	Negroid	248	87.5	10.5	1.6	0.4	-	6.45 \pm 1.02

populations. Since early spontaneous abortions may not be clinically detected, the higher abortion rates registered by Hémon *et al.* (1979) may perhaps be attributed to a better level of self-observation of the women they investigated, that might result in the inclusion of very early abortions in the French data.

Gestational age

Caucasoids and Negroids did not differ significantly in gestational age both for twin births ($t = 1.434$, $0.10 < P < 0.20$) and singletons ($t = 0.241$, $0.80 < P < 0.90$) (Table VII). This similarity was also noted by Luke *et al.* (1991) among non-anomalous Caucasoid and Negroid twins born between 24 and 41 weeks of gestation.

Table VII - Mean gestational age in weeks of Caucasoid and Negroid twin births and controls.

Sample	Race	No.	Mean \pm SD
Twins	Caucasoid	504	36.75 \pm 3.33
	Negroid	136	36.27 \pm 3.50
Controls	Caucasoid	924	39.54 \pm 2.32
	Negroid	195	39.49 \pm 2.69

A mean gestational age of 36.65 ± 3.36 weeks for twins and 39.53 ± 2.39 weeks for singletons born in southeastern Brazil was estimated from Table VII, giving a mean difference of three weeks between the gestational age of twin births and singletons. These values are similar to the European estimates for the length of gestation of twin births (261.6 ± 20.8 days) and singletons (280.5 ± 15.7 days), and to the mean difference (20 days) between the length of gestation of these pregnancies (McKeown and Record, 1952; Powers, 1973; Gedda *et al.*, 1981; Bonnelykke *et al.*, 1987).

The smaller mean gestational age of twin births is due to the very high proportion (44.8%) of preterm deliveries (less than 37 weeks) among them as compared to singletons (9.4%), these proportions being practically the same in the USA (Keith, 1994) and very similar to those observed in the UK (Watson and Campbell, 1986). Our Brazilian series showed 4.3% twin and 9.5% singleton post-term births, these frequencies being similar to those published by Buckler and Buckler (1987) for UK (4.5% for twins), but different from those published by Keith (1994) for USA (6.9% for twins and 28.5% for singletons).

According to Papiernik *et al.* (1985), the proportion of preterm births was reduced to 34% among

women pregnant with twins in a prenatal care program designed to prevent preterm deliveries. However, it has been suggested that prematurity of twin births should be considered as a mechanical rather than a pathological phenomenon, attributed to the excessive distension and erethism of the uterine musculature, as well as to increased fetal mobility (Benirschke and Kim, 1973; Gedda *et al.*, 1981). Gedda *et al.* (1981) also considered probable that multiple pregnancies are associated with an increased fetal production of proteins with an oxytomimetic effect.

Birth weight and birth height

As expected, according to pertinent literature (Gedda *et al.*, 1981; Leroy *et al.*, 1982; Alfieri *et al.*, 1987; Buckler and Buckler, 1987; Bleker *et al.*, 1988; *inter allia*) singletons weighed significantly more than twin births, and males were slightly heavier than females (Table VIII). Also, in agreement with other authors, Caucasoid twin births and singletons were slightly heavier than the corresponding Negroid newborns (Araújo and Salzano, 1975; Luke *et al.*, 1991).

Since besides gestational age and sex of the newborn, birth weight depends on other environmental

Table VIII - Birth weight in g of Caucasoid and Negroid twins and controls classified by sex.

Race	Sex	Twins		Controls	
		No.	Mean \pm SD	No.	Mean \pm SD
Caucasoids	Males	575	2349.94 \pm 598.32	621	3224.38 \pm 528.45
	Females	588	2249.86 \pm 544.29	646	3136.76 \pm 480.81
Negroids	Males	136	2253.38 \pm 680.48	129	3151.94 \pm 518.52
	Females	140	2229.73 \pm 537.50	119	3076.89 \pm 457.55

influences, such as placental weight, feeding restrictions during pregnancy, smoking during pregnancy, maternal height, and parity (Love and Kinch, 1965; Ciari Jr. *et al.*, 1975; Cnattingius *et al.*, 1984; Bantje, 1986; Pilotto *et al.*, 1993, *inter allia*), the slight but consistent differences in birth weight between Caucasoids and Negroids cannot be attributed to a racial effect before these and other environmental variables are taken into account in a multivariate analysis.

Due to the correlation between weight and height at birth, singletons exhibited a significantly larger mean birth height than twin births, and males were slightly larger than females, a result that is in agreement with other data (Leroy *et al.*, 1982; Alfieri *et al.*, 1987; Buckler and Buckler, 1987; Boomsma *et al.*,

Table IX - Birth height in cm of Caucasoid and Negroid twins and controls.

Race	Sex	Twins		Controls	
		No.	Mean \pm SD	No.	Mean \pm SD
Caucasoids	Males	553	45.20 \pm 3.35	621	48.69 \pm 2.25
	Females	572	44.72 \pm 3.09	646	47.96 \pm 2.34
Negroids	Males	118	44.60 \pm 3.09	129	48.27 \pm 2.10
	Females	140	44.13 \pm 3.31	119	47.55 \pm 2.40

1992). Also in agreement with previous observations (Owen and Lubin, 1973), Negroid twin births and singletons were slightly smaller than the corresponding Caucasoid newborns (Table IX).

If the small difference between races is ignored, the mean birth weight of males and females may be estimated as 2331.03 \pm 615.54 g and 2245.86 \pm 610.71 g for twins, and 3211.92 \pm 526.77 g and 3127.45 \pm 477.20 g for singletons, respectively. The mean birth height of males and females was 45.09 \pm 3.32 cm and 44.60 \pm 3.15 cm for twins, and 48.62 \pm 2.23 cm and 47.88 \pm 2.36 cm for singletons, respectively. These birth weights are similar to those observed in other Brazilian populations (references in Araújo and Salzano, 1975) or in South Africa (Essel and Opai-Tetteh, 1994). However, both birth weight and birth height are smaller than those mentioned for European, North-American and Israeli newborns, both for twins and singletons (Armitage *et al.*, 1967; Gedda *et al.*, 1981; Alfieri *et al.*, 1987; Ramos-Arroyo *et al.*, 1988; Blickstein and Weissman, 1990; Voorhorst *et al.*, 1993).

When the twins and singletons are distributed into two classes of birth weight (less than 2500 g and more than 2500 g), it is seen that the proportion of newborns with less than 2500 g is dramatically higher among twin births (57.6% males; 64.5% females) than among singletons (8.2% males; 7.6% females). Similarly when the newborns are distributed into two classes of birth height (less than 44 cm and more than 44 cm), the proportion of children born with less than 44 cm is significantly larger among twin births (23.3% males; 32.6% females).

The data of Luke (1996) demonstrated that the smaller mean length of gestation and the lower birth weight of twins as compared to singletons is, in fact, beneficial to them, since in the United States the lowest fetal death rate for twins was observed at 2500-2800 g and 36-37 weeks of gestation, while singletons showed the lowest fetal death rate at 3700-4000 g at 40-41 weeks. Therefore, Luke's observations (1996) agree with former Gedda *et al.*'s (1981) claim that low birth weight

in twins and in singletons are separate entities and have different implications for child growth and survival. Gedda *et al.* (1981) have also recommended that, "when considering the relation between birth weight and perinatal mortality, the data should always be broken down according to whether they refer to twins or to singletons, rather than combined as it is usually done."

ACKNOWLEDGMENTS

Research supported by CNPq. Publication supported by FAPESP.

RESUMO

Os prontuários das mães de gêmeos caucasóides (589) e negróides (142) nascidos entre 1984 e 1993 e de um grupo controle de mães de crianças nascidas de parto único (1267 caucasóides e 248 negróides) na maior maternidade de Campinas, SP, Brasil, (Maternidade de Campinas) foram investigados para a análise das seguintes informações: categoria da internação hospitalar (clínica particular, INSS e indigentes), estado civil, idade materna, ocorrência de trabalho de parto, tipo de parto, paridade (partos anteriores), abortamentos espontâneos anteriores ao parto, idade gestacional e peso e estatura dos gêmeos e dos nascituros únicos. As principais conclusões foram as seguintes: 1) as mães caucasóides usufruíram, em maior proporção, de internação hospitalar de categoria mais alta, mas a gemelaridade não mostrou associação com a classe social das parturientes; 2) a proporção de mulheres casadas entre as mães caucasóides foi maior do que entre as negróides, e as mães caucasóides de gêmeos incluíram maior proporção de mulheres casadas do que as que tiveram parto único; 3) não se constatou diferença entre caucasóides e negróides quanto a idade média materna, ocorrência de trabalho de parto, tipo de parto, taxa de abortos espontâneos anteriores e idade gestacional; 4) quando comparadas às mães que tiveram parto único, as mães de gêmeos foram, em média, dois anos mais velhas, entraram menos freqüentemente em trabalho de parto, foram submetidas mais freqüentemente à cirurgia cesariana e tiveram maior taxa de abortos espontâneos, enquanto que os gêmeos tiveram menor idade média gestacional (três semanas) que os nascidos de parto único; 5) as mulheres caucasóides tiveram menor paridade que as negróides e as mães de gêmeos maior paridade que as de partos únicos; 6) os gêmeos mostraram peso médio e estatura média menor que os nascidos de parto único, os recém-nascidos do sexo masculino mostraram peso levemente superior aos do sexo feminino, sendo os negróides mais leves e menores do que os caucasóides ao nascimento.

REFERENCES

- Akanlawon, A.O. and Ejiwunmi, A.B. (1986). Biological factors in multiple births in Lagos. *East Afr. Med. J.* 63: 115-120.
- Alfieri, A., Gatti, I. and Alfieri, A.C. (1987). Weight and height growth in twins and children born in the last decade. *Acta Genet. Med. Gemellol.* 36: 209-211.
- Allen, G. and Parisi, P. (1990). Trends in monozygotic and dizygotic twinning rates by maternal age and parity. Further analysis of Italian data, 1949-1985, and re-discussion of US data, 1964-1985. *Acta Genet. Med. Gemellol.* 39: 317-328.
- Allen, G. and Schachter, J. (1971). Ease of conception in mothers of twins. *Soc. Biol.* 18: 18-27.
- Araújo, A.M. and Salzano, F.M. (1975). Parental characteristics and birth weight in a Brazilian population. *Hum. Biol.* 47: 37-43.
- Armitage, P., Boyd, J.D., Hamilton, W.J. and Rowe, B.C. (1967). A statistical analysis of a series of birth-weights and placental weights. *Hum. Biol.* 39: 430-444.
- Azubuiké, J.C. (1982). Multiple births in Igbo women. *Brit. J. Obstet. Gynaecol.* 89: 77-79.
- Bantje, H. (1986). A multiple regression analysis of variables influencing birthweight. *Trop. Geogr. Med.* 38: 123-130.
- Beiguelman, B. and Villarroel-Herrera, H.O. (1993). Factors influencing the decline of twinning incidence in a south-eastern Brazilian population. *Braz. J. Genet.* 16: 793-801.
- Belitzki, R., Fescina, R.E. and Uceda, F. (1978). Definiciones y terminologias aplicables al periodo perinatal. Recomendaciones de la Organización Mundial de la Salud y modificaciones de la F.I.G.O. *Publ. Cient. del CLAP, No. 757*: 136-147.
- Benirschke, K. and Kim, C.K. (1973). Multiple pregnancy. *N. Engl. J. Med.* 288: 1329-1336.
- Bertranpetit, J. and Marin, A. (1988). Demographic parameters and twinning: a study in Catalonia, Spain. *Acta Genet. Med. Gemellol.* 37: 127-135.
- Bleker, O.P., Oosting, J. and Hemrika, D.J. (1988). On the cause of the retardation of fetal growth in multiple gestations. *Acta Genet. Med. Gemellol.* 37: 41-46.
- Blickstein, I. and Weissman, A. (1990). Birth weight discordancy in male-first and female-first pairs of unlike-sexed twins. *Am. J. Obstet. Gynecol.* 162: 661-663.
- Bonnelykke, B. (1990). Maternal age and parity as predictors of human twinning. *Acta Genet. Med. Gemellol.* 39: 329-334.
- Bonnelykke, B., Sogaard, J. and Nielsen, J. (1987). Seasonality in twin birth rates, Denmark, 1936-1984. *J. Epidemiol. Community Health* 41: 338-343.
- Boomsma, D.I., Orlebeke, J.F. and Van Baal, G.C.M. (1992). The Dutch twin register: growth data on weight and height. *Behav. Genet.* 22: 247-251.
- Buckler, J.M.H. and Buckler, J.B. (1987). Growth characteristics in twins and higher order multiple births. *Acta Genet. Med. Gemellol.* 36: 197-208.
- Bulmer, M.G. (1959). The effect of parental age, parity and duration of marriage on the twinning rate. *Ann. Hum. Genet.* 23: 454-458.
- Campbell, D.M., Campbell, A.J. and MacGillivray, I. (1974). Maternal characteristics of women having twin pregnancies. *J. Biosoc. Sci.* 6: 463-470.
- Cannatelli, L., Gitto, E., Prudente, D., Cordaro, V., Cordaro, S., Liotta, C. and Barberi, I. (1994). An epidemiologic study on the correlation between clinical symptomatology and modality of birth in twins. *Acta Genet. Med. Gemellol.* 43: 108-109.
- Chen, C.J., Lin, T.M., Chang, C. and Cheng, Y.J. (1987). Epidemiological characteristics of twinning rates in Taiwan. *Acta Genet. Med. Gemellol.* 36: 335-342.
- Ciari Jr., C., Marcondes de Almeida, P.A. and Siqueira, A.A.F. (1975). Relação entre o peso da criança ao nascer, altura materna, idade gestacional e restrição alimentar em gestantes normais. *Rev. Saúde Pública* 9: 33-42.
- Cnattingius, S., Axelsson, O., Eklund, G., Lindmark, G. and Meirik, O. (1984). Factors influencing birth weight for gestational age, with special respect to risk factors for intrauterine growth retardation. *Early Hum. Dev.* 10: 45-55.
- Elwood, J.M. (1978). Maternal and environmental factors affecting twin births in Canadian cities. *Br. J. Obstet. Gynaecol.* 85: 351-358.
- Eriksson, A.W. and Fellman, J. (1967). Twinning and legitimacy. *Hereditas* 57: 395-402.
- Essel, J.K. and Opai-Tetteh, E.T. (1994). Twin birth-weight discordancy in Transkey. *S. Afr. Med. J.* 84: 69-71.
- Freire-Maia, N. and Krieger, H. (1963). A Jewish isolate in southern Brazil. *Ann. Hum. Genet.* 27: 31-39.
- Gedda, L., Brenci, G. and Gatti, I. (1981). Low birth weight in twins versus singletons: separate entities and different implications for child growth and survival. *Acta Genet. Med. Gemellol.* 30: 1-8.
- Hémon, D., Berger, D. and Lazar, P. (1979). The etiology of human dizygotic twinning with special reference to spontaneous abortions. *Acta Genet. Med. Gemellol.* 28: 253-258.
- Imaizumi, Y. (1992). Twinning rates in Japan, 1951-1990. *Acta Genet. Med. Gemellol.* 41: 165-175.
- Imaizumi, Y. and Inouye, E. (1979). Analysis of multiple birth rates in Japan. *Acta Genet. Med. Gemellol.* 28: 107-124.
- James, W.H. (1981). Dizygotic twinning, marital stage and status and coital rates. *Ann. Hum. Biol.* 8: 371-378.
- James, W.H. (1986). Recent secular trends in dizygotic twinning rates in Europe. *J. Bios. Sci.* 18: 497-504.
- Keith, L. (1994). Mortality and morbidity among twins: recent observations from the United States. *Acta Genet. Med. Gemellol.* 43: 25-31.
- Khoury, M.J. and Erikson, J.D. (1983). Maternal factors in dizygotic twinning: evidence for interracial crosses. *Ann. Hum. Biol.* 10: 409-416.
- Krieger, H. (1972). Inbreeding effects on mortality in northeastern Brazil. *An. Acad. Bras. Ciênc.* 44: 535-548.

- Leroy, B., Lefort, F., Neveu, P., Risse, R.J., Trévisé, P. and Jeny, R.** (1982). Intrauterine growth charts for twin fetuses. *Acta Genet. Med. Gemellol.* 31: 199-206.
- Love, E.J. and Kinch, R.A.** (1965). Factors influencing the birth weight in normal pregnancy. *Am. J. Obstet. Gynec.* 91: 342-349.
- Luke, B.** (1996). Reducing fetal deaths in multiple births: optimal birth weight and gestational ages for infants of twin and triple births. *Acta Genet. Med. Gemellol.* 45: 333-348.
- Luke, B., Witter, F.R., Abbey, H., Feng, T., Namnoum, A.B., Paige, D.M. and Johnson, T.R.B.** (1991). Gestational age-specific birthweights of twins versus singletons. *Acta Genet. Med. Gemellol.* 40: 69-76.
- Marinho, A.O., Ilesanmi, A.O., Ladele, O.A., Asuni, O.H., Omigbodun, A. and Oyejide, C.O.** (1986). A fall in the rate of multiple birth in Ibadan and Igbo Ora, Nigeria. *Acta Genet. Med. Gemellol.* 35: 201-204.
- McKeown, T. and Record, R.G.** (1952). Observations on foetal growth in multiple pregnancy in man. *J. Endocrinol.* 5: 387-401.
- Murphy, M. and Botting, B.** (1989). Twinning rates and social class in Great Britain. *Arch. Dis. Child.* 64: 272-274.
- Murphy, M. and Seagroatt, V.** (1992). Twin peaks, extramarital conceptions, and virgin births: is there a connection? *Arch. Dis. Child.* 67: 189-191.
- Myriantopoulos, N.C.** (1970). An epidemiological survey of twins in a large prospectively studied population. *Am. J. Hum. Genet.* 22: 611-629.
- Nylander, P.P.S.** (1981). The factors that influence twinning rates. *Acta Genet. Med. Gemellol.* 30: 189-202.
- Olofsson, P. and Rydhström, H.** (1985). Management in second stage of labour in term twin delivery. *Acta Genet. Med. Gemellol.* 34: 213-216.
- Owen, G.M. and Lubin, L.H.** (1973). Anthropometric differences between black and white preschool children. *Am. J. Dis. Child.* 126: 168-169.
- Pachi, A., Paesano, R., Giorgetti, T., Conti-Puorger, C., Petrelli, V., Ianiro, G., Rocino, M.T. and Spera, G.** (1994). Obstetrical implications in multiple pregnancies. *Acta Genet. Med. Gemellol.* 43: 33-43.
- Papiernik, E., Mussly, M.A., Vial, M. and Richard, A.** (1985). A low rate of perinatal deaths for twin births. *Acta Genet. Med. Gemellol.* 34: 201-206.
- Picard, R., Fraser, D., Hagay, Z.J. and Leiberman, J.R.** (1989). Twinning in southern Israel; secular trends, ethnic variation and effects of maternal age and parity. *Eur. J. Gynecol. Reprod. Biol.* 33: 131-139.
- Pilotto, R.F., Magna, L.A. and Beiguelman, B.** (1993). Factors influencing human birth weight in normal pregnancy: a prospective study in a Brazilian university hospital. *Braz. J. Genet.* 16: 457-469.
- Pollard, R.** (1996). Ethnic variation of twinning rates in Malawi. *Acta Genet. Med. Gemellol.* 45: 361-365.
- Powers, W.F.** (1973). Twin pregnancy, complications and treatment. *Obstet. Gynecol.* 42: 795-808.
- Ramos-Arroyo, M.A., Ulbright, T.M., Yu, P.-L. and Chirstian, J.C.** (1988). Twin study: relationship between birth weight, zygosity, placentation, and pathologic placental changes. *Acta Genet. Med. Gemellol.* 37: 229-238.
- Rezende, J.** (1988). *Obstetrícia*. 5th. edn. Guanabara Koogan, Rio de Janeiro, RJ.
- Shibley, P.W., Wray, J.A., Hechter, H.H., Arellano, M.G. and Borhant, N.O.** (1967). Frequency of twinning in California. Its relationship to maternal age, parity and race. *Am. J. Epidemiol.* 85: 147-156.
- Smith, A.** (1974). Observations on the determinants of human multiple births. *Annual Report of the Registrar General for Scotland, 1964*. Apud Nylander, P.P.S. (1981).
- Voorhorst, F.J., Bouter, L.M., Bezemer, P.D. and Kurver, P.H.J.** (1993). Maternal characteristics and expected birth weight. *Eur. J. Obstet. Gynecol. Reprod. Biol.* 50: 115-122.
- Watson, P. and Campbell, D.M.** (1986). Preterm deliveries in twin pregnancies in Oxford. *Acta Genet. Med. Gemellol.* 35: 193-199.

(Received March 10, 1997)