



Acta Genet Med Gemellol 40: 311-317 (1991)  
© 1991 by The Mendel Institute, Rome

Received 27 November 1990  
Final 4 March 1991

## Ethnicity and Sex Ratio in Twin Births

R. Picard<sup>1</sup>, D. Fraser<sup>2</sup>, E. Picard<sup>3</sup>

<sup>1</sup>*Division of Obstetrics and Gynecology, Soroka Medical Center, <sup>2</sup>Epidemiology and Health Services Evaluation Unit, Faculty of Health Sciences, Ben-Gurion University of the Negev, and*

<sup>3</sup>*Division of Pediatrics, Soroka Medical Center Beer-Sheva, Israel*

---

**Abstract.** The patterns of sex ratio in Israeli twins by maternal age and parity are described in two ethnic subpopulation. Jews and Bedouins differ one from the other in genetic, environmental, lifestyle, and reproductive factors. In the Jewish subpopulation, the proportion of males was significantly lower in twin than in singleton births; parity increased the odds of male twin births while maternal age had the inverse effect. In the Bedouin subpopulation, the sex ratio did not differ significantly from that of singletons, and no consistent patterns were found by maternal age and parity. The data suggest that several factors may influence the sex ratio in twin births. In Jewish twin births, the findings are consistent with the literature and can be largely explained in terms of high level of maternal gonadotropins. In the Bedouin subpopulation, paternal influence which could be related to lifestyle may be present, and as yet undefined genetic factors may also be involved. It would be of great interest, therefore, to continue monitoring of the effects of changes in lifestyle on the Bedouin population in order to tease out the relative importance of the varying factors on the sex ratio of twin births.

**Key words:** Sex ratio, Twins, Maternal age, Parity, Ethnicity

---

## INTRODUCTION

The sex ratio, ie, the proportion of males in twin births is known to be low. The reasons for this low ratio are not yet clear but several hypotheses have been put forward, including theories about maternal gonadotropin level at the time of conception [2,5,9,13] and proneness of female embryo to divide [16].

James [6,7] found that the ratio of males to females in Whites was higher than in Blacks, and that Oriental births had a sex ratio even higher than that described for White

births. James [8] also showed that infants born to women after hormonal induction of ovulation by gonadotropin or clomiphene had a particularly low sex ratio, and that the ratio in twins rises and then falls with maternal age [4]. There is a suggestion, therefore, that sex ratio is influenced by ethnic origin, maternal age and hormonal levels.

The population in our area consists of two major ethnic groups, Jews and Bedouins, who differ one from the other in genetic makeup, environmental and lifestyle factors, and in reproductive patterns. Bedouin women have more children than Jewish women, and a longer span of reproductive years.

The aim of our study was to examine the sex ratio in Israeli twins, in the Jewish and Bedouin subpopulations, and to evaluate the unique effects of maternal age and parity on the sex ratio in twin births of different ethnic groups, in order to gain understanding of the biological factors which influence it.

## MATERIALS AND METHODS

The study population consisted of all twin deliveries which had occurred at the Soroka Medical Center between January 1970 and December 1986. The population in our area includes Bedouins and Jews, the former constituting 15% of the population but contributing more than one third of the births. Both subpopulations share a freely accessible prenatal and delivery service, and deliver at one major hospital. No other maternity facility exists in the area, and there are about 7500 births annually. The study population has been described in more detail elsewhere [14,15]. Data on all twin births were collected retrospectively from maternal delivery charts and delivery room records. There were 1394 twin deliveries during this period (12.3% deliveries) in which sex was recorded for both twins each of which weighed 500 grams or more. Maternal age and parity was available for births in 1977 to 1986: thus, this information exists for 56% and 48% of the deliveries, respectively. Comparative information on singleton births in this population is available for 1986 from the records of the Division of Obstetrics and Gynecology of the Soroka Medical Center.

### Data Analysis

Sex ratio was calculated as the number of males per 100 females. Parity was divided into four groups, first and second infants, third and fourth infants, fifth and sixth infants and seventh or more. Maternal age at delivery was classified as 24 years or younger, 25-34 and 35 years or older.

To examine the deviation of sex ratio from that found in singleton births, the chi-square goodness-of-fit test was used. The number of observed male and female infants was compared to the number expected from the sex distribution in singleton births, according to ethnic group, maternal age, and parity. The effects of ovulation-inducing drugs on the sex ratio were examined. For this comparison, the sex ratio of untreated twin births was used as well as that of singleton births. Unconditional multiple logistic regression analysis was used to estimate the unique effects of maternal age (in five-year age groups) and parity (coded as number of births) on the sex ratio in twin births. The

effects of maternal age and parity on the odds ratio of the birth of male infants as compared with female infants were calculated and 95% confidence intervals computed (95% CI) [1].

**RESULTS**

The sex ratio in the combined twin population, like that of the Jewish subpopulation was significantly lower than the corresponding sex ratio of singleton births ( $p < 0.025$  and  $p < 0.01$ , respectively: Table 1). However, in the Bedouin subpopulation, the sex ratio was higher than in the Jewish one, and did not differ significantly from that of singleton Bedouin infants. In the subgroup of 1977-1986 births, for which maternal age and parity data are available, the sex ratio of Bedouin twin births was somewhat lower, 93.5, but still did not differ from that of singleton births.

**Table 1 - Sex ratio in 1394 twin deliveries, by ethnic origin**

Ethnic group	Number of twins		Sex ratio (M: 100 F)		$\chi^2$	p
	Male	Female	Twins	Singletons		
All <sup>a</sup>	1360	1425	95.4	104.9	6.24	<0.025
Jews <sup>a</sup>	962	1039	92.6	105.5	7.81	<0.01
Bedouins	398	386	103.1	103.8	0.01	ns

<sup>a</sup> Including 3 cases of fetus papyraceous (sex unknown)

Table 2 describes the Jewish and Bedouin sex ratio of twins born after ovulation-inducing treatment (gonadotropin or ciclomiphene). The Jewish twin sex ratio is significantly lower than that of singleton births, but does not differ significantly from the sex ratio of twins whose mothers did not use hormonal treatment. In the Bedouin infants,

**Table 2 - Effects of ovulation-inducing hormones on sex ratio in Jewish and Bedouin twin births**

Ethnic group	No. of twins		Sex ratio (M: 100 F)			$\chi^2$ (1 df)		
	Male	Female	Twins, mothers treated	Twins, mothers untreated	Singletons	a	b	p
All <sup>a</sup>	40	57	70.2	95.4	104.9	2.26	3.88	<0.05
Jews <sup>a</sup>	36	53	67.9	92.6	105.5	2.08	4.23	<0.05
Bedouins	4	4	100.0	103.1	103.8	ns	ns	

<sup>a</sup> Including one case of unknown sex (fetus papyraceous).

only four sets of twins were born after ovulation-inducing treatment, and their sex ratio did not differ from that of singleton Bedouin infants or twins born without ovulation inducing treatment.

The effects of maternal age on sex ratio in Jewish and Bedouin births are shown in Table 3. Twins of younger mothers in both subpopulations had sex ratios exceeding 130. This value was significantly higher than the sex ratio of singleton infants of women aged less than 25 years in the combined population and in Jewish women ( $\chi^2=5.25$ ,  $p<0.025$ , and  $\chi^2=4.64$ ,  $p<0.05$ , respectively). The sex ratio of twin births was lower in older women, decreasing with age in Jewish infants, while decreasing and then rising again in twins born to Bedouin women.

**Table 3 - Sex ratio in 1394 twin deliveries by ethnic origin and maternal age**

Ethnic group	Maternal age	No. of twins		Sex ratio (M: 100 F)		$\chi^2$ (7 df)	p
		Male	Female	Twins	Singletons		
All <sup>a</sup>	<25	193	140	137.9	107.0	17.51	<0.025
	25-29	240	284	84.5	104.8		
	30-34	212	242	87.6	105.4		
	35+	113	137	82.5	100.2		
Jews <sup>a</sup>	<25	137	98	139.8	105.2	14.61	<0.05
	25-29	174	198	87.9	106.8		
	30-34	166	191	86.9	107.5		
	35+	66	86	76.6	99.9		
Bedouins	<25	56	42	133.3	109.1	4.22	ns
	25-29	66	86	76.7	100.4		
	30-34	46	51	90.2	100.8		
	35+	47	51	92.2	100.7		

<sup>a</sup> Including 3 cases of fetus papyraceous (sex unknown)

While the changes in sex ratio of twin births display a clear pattern with maternal age, the pattern of sex ratios with parity is much less clear (Table 4). In the Jewish subpopulation, a trend for increasing sex ratio with increasing parity seems to exist.

In order to examine the unique effects of parity and maternal age, which are highly associated, an unconditional logistic regression analysis was used (Table 5). This analysis shows that the two subpopulations are extremely different. Thus, in the twins of Jewish mothers, parity increased the odds of a birth of male twins while maternal age decreased it, and each were independent and significant statistically. This model reinforces the findings described previously, showing that more males are born to younger mothers while parity acts inversely. In the Bedouin subpopulation, there were no clear effects of either maternal age or parity in either the univariate or the multivariate analysis.

**Table 4 - Sex ratio in 1394 twin deliveries by ethnic origin and parity**

Ethnic group	Parity	No. of twins		Sex ratio		$\chi^2$ (7 df)	p
		Male	Female	Twins	Singletons		
All <sup>a</sup>	1-2	244	290	84.1	106.1	22.90	< 0.05
	3-4	241	204	118.1	104.3		
	5-6	55	97	56.7	104.4		
	7+	112	99	113.1	101.1		
Jews <sup>a</sup>	1-2	208	250	83.2	105.9	17.43	< 0.01
	3-4	189	168	112.5	104.3		
	5-6	36	57	63.2	104.1		
	7+	34	17	200.0	105.4		
Bedouins	1-2	36	40	90.0	106.6	11.78	ns
	3-4	52	36	144.4	101.9		
	5-6	19	40	47.5	104.8		
	7+	78	82	95.1	100.2		

<sup>a</sup> Including 3 cases of fetus papyraceous (sex unknown).

**Table 5 - Results from an unconditional logistic regression analysis, assessing the effects of maternal age (in 5-years age groups) and parity (coded as number of births), on the odds of a birth of a male vs a female twin. The odds ratios and 95% confidence intervals (95% CI) are presented for univariate and multivariate models.**

Ethnic group	Model number	Variables	Odds ratio	95% CI	p
Jews	1	Maternal age	0.82	0.68-0.99	0.0346
	2	Parity	1.10	1.00-1.22	0.0503
	3	Maternal age	0.63	0.50-0.80	0.0001
		Parity	1.26	1.12-1.43	0.0002
Bedouins	1	Maternal age	0.96	0.75-1.23	0.7370
	2	Parity	1.01	0.92-1.11	0.8026
	3	Maternal age	0.84	0.57-1.26	0.4012
		Parity	1.06	0.91-1.24	0.4185

## DISCUSSION

Our data confirm the findings of lower sex ratio in twin births described elsewhere. However, the pattern is inconsistent when examined in the two different subpopulations residing in our area.

In the Bedouin subpopulation, the sex ratio is higher than in the Jewish subpopulation and does not differ from that of Bedouin singletons. The differences in sex ratio between Jews and Bedouins may be due to differences in lifestyle between the two groups. Bedouins have generally been farmers or shepherds and their way of life was perhaps less stressful than that of the Jewish men who have led a modern and possibly more stressful lifestyle. Lyster [12] has reported that the sex ratio of offspring of men with stressful occupations tends to be low, while Kreuze et al [11] have shown that in males, stress reduces testosterone levels: so, stress effects on sex ratio may be mediated via changes in testosterone levels. The theory that lifestyle may affect the twin sex ratio is supported by our finding that the more recent births of 1977-1986, the sex ratio of twins born to Bedouin women was lower than that for the period under study. It should be noted that the Bedouins of southern Israel are in a transition from tradition to "western-like" lifestyle. This transition has brought about changes in health parameters, such as alterations in the pattern of cardiovascular risk factors [3], and similar changes may be occurring in sex ratio in twin births.

The effects of maternal age and parity on the sex ratio of twin births, were also different in the two subpopulations. A reduction of sex ratio with maternal age was found in the Jewish population, while in Bedouin mothers, a decrease followed by an increase was found, which was similar to that described by James [4]. Milham [13] and Bulmer [2] have shown that dizygotic (DZ) twinning is partially dependent on maternal gonadotropin levels and James [4] and our own data indicate that twins born following the induction of ovulation have a lower sex ratio than the general population. Thus, if sex ratio and dizygosity were both hormonally related, then DZ twinning rate and sex ratio should be inversely associated in populations. In Jewish mothers this appears to be the case [14] and the hypothesis of gonadotropin effects on the sex ratio of twin births is supported. In Bedouin mothers, however, the highest rates of DZ twinning were found in women aged 30 years or older [14], while the sex ratio in their twins was increasing. Elevated gonadotropin levels alone, therefore, cannot explain the relationship between sex ratio and twinning in the Bedouin population. It should also be noted that, in the Bedouin population, the effects of maternal age and parity are extremely difficult to separate, as the pattern of early first birth and many subsequent births is a consistent one, affecting most of the population.

It appears from the data that parental hormonal effects do not satisfactorily explain the differences in sex ratio patterns by maternal age and parity between Jews and Bedouins in our population. Khoury et al [10] have described paternal influence on sex ratio in black infants, which could imply that a genetic factor may exist, unrelated to parental hormonal factors, or one which modifies parental hormonal effects in different ways in different populations, which could influence the sex ratio in twin births.

With regard to the effect of ovulation-inducing agents, our findings are similar to those described in the literature. The sex ratio in twins born after clomiphene or gonadotropin treatment is significantly lower than the singleton sex ratio. We did not find, however, any difference in sex ratio between spontaneous twin pregnancies and gonadotropin or clomiphene-induced twin pregnancies. This may be due to preexisting high maternal levels of gonadotropins which contribute to the lower sex ratio of all twin births.

## REFERENCES

1. Breslow NE, Day NE (1980): Statistical methods in cancer research. Volume 1. The analysis of case-control studies. Lyon: International Agency for Research on Cancer (IARC Scientific publication No. 32) pp 192-246.
2. Bulmer MG (1970): *The Biology of Twinning in Man*. Oxford: Clarendon Press.
3. Fraser D, Weitzman S, Blondheim S, Shany S, Abou-Rbiah Y (1990): The prevalence of cardiovascular risk factors among Bedouins: A population in transition. *Eur J Epidemiol* 6:273-278.
4. James WH (1975): Sex ratio in twin births. *Ann Hum Biol* 2:365-378.
5. James WH (1980): Time of fertilization and sex of infants. *Lancet* I:1124-1126.
6. James WH (1984): The sex ratio of black births. *Ann Hum Biol* 11:39-44.
7. James WH (1985): The sex ratio of oriental births. *Ann Hum Biol* 12:485-487.
8. James WH (1985): The sex ratio of infants born after the hormonal induction of ovulation. *Br J Obstet Gynecol* 92:299-301.
9. James WH (1986): Hormonal control of sex ratio. *J Theoret Biol* 118:427-441.
10. Khoury MJ, Erickson JD, James LM (1984): Paternal effects on the human sex ratio at birth: Evidence from interracial crosses. *Am J Hum Genet* 36:1103-1111.
11. Kreuze LE, Rose RM, Jennings JR (1972): Suppression of plasma testosterone: Levels and psychological stress. A longitudinal study of young men in officer candidate school. *Arch Gen Psychiat* 26:479-482.
12. Lyster WR (1982): Altered sex ratio in children of divers. *Lancet* II:152.
13. Milham S Jr (1964): Pituitary gonadotropin and dizygotic twinning. *Lancet* II:566.
14. Picard R, Fraser D, Hagay ZY, Leiberman JR (1989): Twinning in southern Israel: Secular trends, ethnic variation and effects of maternal age and parity. *Eur J Obstet Gynecol Reprod Biol* 33:131-139.
15. Picard R, Fraser D, Hagay ZJ, Leiberman JR (1990): Seasonal variation and effects of ethnicity, maternal age and parity. *J Reprod Med* 35:163-167.
16. Cunningham FG, MacDonald PC, Gant NF (1989): In: *Williams Obstetrics*, 18th Edition. Norwalk, Connecticut: Appleton & Lange, pp 629-652.

**Correspondence:** Dr. Drora Fraser, Epidemiology and Health Services Evaluation Unit, Faculty of Health Sciences, Ben-Gurion University of the Negev, P.O. Box 653, Beer Sheva 84105, Israel.