

# The Association Between Menarche Age and First Offspring Sex Ratio

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## Abstract

**Background:** Offspring sex ratio (OSR) serves as an important social factor, and various other factors are hypothesized to be associated with it, such as maternal diet, time of ovulation and insemination, environmental phenomena, parental age, and infertility treatment.

**Objectives:** This research was performed to assess the association between mothers' menarche age, first pregnancy age, and sex ratio of first offspring.

**Patients and Methods:** In this retrospective study, 2,000 Iranian women of reproductive age were recruited to assess their menarche age, first pregnancy age, and first OSR.

**Results:** The mean age of the participants was  $29.6 \pm 7.09$ , their mean menarche age was  $13.25 \pm 1.21$ , and the mean age of their first pregnancy was  $23.9 \pm 4.35$ . Total OSR was 0.932. The OSR (calculated as the proportion of male to female offspring) was higher when the menarche age was younger ( $P < 0.05$ ). In women of younger pregnancy age, the OSR was higher ( $P < 0.05$ ). First pregnancy age was younger in women with a menarche age under 13 years ( $P < 0.05$ ).

**Conclusions:** Women of younger menarche age will have younger first pregnancy ages and a greater chance of having a male first offspring.

**Keywords:** Menarche Age, First Offspring Sex Ratio, First Pregnancy Age, Iran

## 1. Background

The age of the onset of menarche is affected by various factors, the most important of which have proven to be nutritional and health status, quality of life, socioeconomic status, and body size (1-3). There are also a number of others that include genetic, racial and geographic factors (4, 5) and maternal or paternal factors, such as the mother's menarche age, maternal age at the child's birth, parents' smoking during pregnancy, etc. (6, 7). Girls with better socioeconomic status and higher body mass index (BMI) seem to have earlier menarche, which is hypothesized to be associated to hormone mediators (8, 9). These factors make the mean menarche age variable in different societies.

Offspring gender is an important ecological issue in societies, as it may influence the family size (10), parents' behavior and care, and governmental strategies (11).

The offspring sex ratio (OSR) is reported to be variable in different societies and in different eras. Fukuda has reported a male to female sex ratio of 1.04 in Japanese society in 2002 and 2011 (12, 13). But, some countries have reported decreasing or increasing OSR during recent decades (14, 15). The latest studies of OSR in Iran were obtained in

2002 and reported an OSR of 0.52 in 1976, which decreased slightly in 2000 due to the Iran-Iraq War (16). However, no recent studies are available on the OSR of the Iranian population.

Studies have associated many factors to offspring gender, such as birth order, paternal age, digit length ratio (17, 18), parental hormone levels, drugs and toxins (19-21), maternal nutrition, physical and or mental health status (22, 23), time of intercourse, and infertility treatment (24, 25). Although some factors are hypothesized to be associated with sex ratio, the mechanisms remain unclear, although Navara (23) has reviewed some possible mechanisms. Recent studies have associated mother's menarche age to child's gender (13).

In societies like Iran, where the gender of the child is of great importance for families and has a great impact on the society, assessing the determinants of sex ratio is valuable. Thus, we intended to assess the possible association between mother's menarche age and sex ratio of the offspring, identifying the sex ratio of offspring, which has not yet been reported in Iran, as far as we know.

## 2. Objectives

This research was performed to assess the association between mothers' menarche age, first pregnancy age, and sex ratio of first offspring.

## 3. Patients and Methods

This study retrospectively assessed all Iranian women of reproductive age who were referred from 2010 to 2014 to Akbarabadi and Rasule Akram hospitals in Tehran, Iran and Kasra hospital in Karaj, Iran. Cases included women who had at least one child that was born after 20 weeks of gestation. Patients with a history of infertility, endocrine disorders, and polycystic ovarian syndrome and patients who used assisted reproductive techniques for their first pregnancy were excluded from analysis. From the 2,000 women included in our study, demographic data, including mother's age, parity, gravidity, menarche age, gender of children, and age at first delivery were collected. The protocol of the study was approved by the ethics committee of Iran University of Medical Sciences. Written, informed consent was obtained from all participants.

### 3.1. Statistical Analysis

Numerical variables were reported as mean  $\pm$  standard deviation (SD) when normally distributed, otherwise as median plus range. The chi-square test was used to evaluate the association between menarche age categories and first offspring sex.  $P \leq 0.05$  was considered to be statistically significant. All analyses were performed using SPSS for Windows version 14 (SPSS Inc., Chicago, IL, USA).

## 4. Results

Analysis was performed on the complete data of 1,664 of the 2,000 women included in our study. Mean age of the study population was  $29.6 \pm 7.09$ . Mean menarche age and parity were equal to  $13.25 \pm 1.21$  and  $1.59 \pm 0.8$ , respectively.

Of all participants, 971 (57.9%) were 25 - 35 years of age, and 441 (26.5%) were 15 - 25 years of age. In this study, the age at menarche in 18.4% (307) of the participants was under 13 years, 77.2% (1,285) between 13 - 15, and 4.4% (72) over 15 years of age. Characteristics of the study population are shown in Table 1.

The OSR was also calculated as the proportion of male to female sex, which was 0.932 in this study population. The OSR was higher when the menarche age occurred earlier. This means that there is a first offspring sex trend toward the male sex when menarche occurs at an earlier age. Table 2 demonstrates the OSR in different menarche age

**Table 1.** Characteristics of Study Population (n = 1664)<sup>a</sup>

Characteristics	
Age	29.6 (7.09)
Gravidity	1.71 (1.00)
Parity	1.59 (90.88)
Menarche age	13.25 (1.21)
Menarche age, No. (%)	
< 13 years	307 (18.4%)
13 - 15 years	1,285 (77.2%)
> 15 years	72 (4.4%)
BMI	25.22 (5.03)
Age of first pregnancy	23.09 (4.35)
Age of first pregnancy, No. (%)	
< 20 years	378 (22.9)
20 - 30 years	1,051 (63.2)
> 30 years	232 (13.9)
First OSR, male/female	0.932

<sup>a</sup>Values are expressed as mean (SD) unless otherwise indicated.

categories. This difference was statistically significant, as shown in the

The OSR is also influenced by first pregnancy age. As shown in Table 2, in early pregnancy ages, OSR would be higher, which means first offspring sex has a statistically significant trend toward male when pregnancy age is earlier.

When the first pregnancy age for different menarche ages were compared, it showed an earlier pregnancy age in women with a menarche age under 13 years old. First pregnancy age was  $23.62 \pm 4.49$ ,  $24.50 \pm 4.48$ , and  $24.30 \pm 5.69$  in women with a menarche age < 13 years, 13 - 15 years, and > 15 years, respectively. This difference was statistically significant ( $P = 0.005$ ).

## 5. Discussion

This study found that women with an earlier menarche age will have an earlier first pregnancy age. The OSR was higher when the menarche age was younger, which means that there is a first offspring sex trend toward male when the menarche age is younger. At earlier pregnancy ages, OSR was higher, which means that there is a first offspring sex trend toward male when the pregnancy age is younger.

The mean age of menarche is reported to vary among different nations. With Egyptian girls, it ranges from 12 - 13.7 years of age (3), and in Iran, it was estimated to be

**Table 2.** First OSR in Different Menarche Ages and Different Pregnancy Ages

	First OSR (Male/Female)	P Value
<b>Total</b>	0.932	
<b>Menarche age, y</b>		0.0001
< 13	1.16	
13 - 15	0.94	
> 15	0.35	
<b>Age at first pregnancy, y</b>		0.0001
< 20	1.31	
20 - 30	0.54	
> 30	0.7	

around 13 years of age in a review done in 2002 (26). In this study, the mean menarche age was  $13.25 \pm 1.21$ , which was in line with previous results.

The first male to female OSR was 0.932 in this study population. This shows female dominance in the studied population. A decline in male to female OSR has been reported in many countries, including Denmark, England, the USA, Germany, and Japan (14, 27-30). The etiology of the male sex reduction rate is not yet known, but it seems to be multifactorial. Chronic exposure to toxic environmental agents, including tobacco smoke (13), and generally high stress situations, such as that witnessed in connection with the Kobe earthquake in Japan (31), or after the Bam earthquake in Iran (32), could be responsible. Some studies have also associated parental age to OSR. Matsuo et al. have investigated 3,049 deliveries, and they found a male dominant OSR in Japanese society and have proposed that older parental age is associated with reduced OSR (32). In this study, the male to female OSR was 0.932, and this is consistent with the other studies that show male dominance at younger pregnancy ages.

As this study's results show, women at earlier menarche ages have a higher probability of giving birth to a boy as their first offspring. Fukuda et al. studied 10,847 premenopausal women in 2011, and they concluded that women entering menarche outside the normal age range, especially those with earlier menarche, may have an increased chance of producing female offspring (13). In contrast, this study shows earlier menarche age (under 13) causes the sex ratio of the offspring to trend towards male. However, in line with their study, this study shows that a menarche age over 15 trends toward the first offspring being female. This difference may be caused by the different study population ages. Their participants had a mean age of  $37.5 \pm 7.2$ , compared with  $29.6 \pm 7.09$  in this study.

## 5.1. Conclusion

As OSR is an important social factor, larger studies in different ethnic populations are required to assess the exact associations between menarche age, first pregnancy age, and offspring sex ratio and also to evaluate other possible underlying mechanisms.

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## Footnotes

**Authors' Contribution:** All authors have contributed equally to this study.

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