Nationwide prevalence of infertility in Iranian couples: findings from a 2019 study

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Abstract

Background Updated knowledge on the prevalence of infertility is essential for designing effective preventive measures. This study aims to estimate the period prevalence of 12 and 24-month primary and secondary infertility and explore their geographic distribution in Iran.

Methods This is a nationwide cross-sectional population-based survey conducted in Iran. The study included more than 30,000 married women aged between 15 and 49, recruited using a multi-stage sampling method. The data were collected through face-to-face interviews conducted in 2019, from November to December. Self-reported information on socio-demographic data, pregnancy history, and time to pregnancy was collected. The retrospective time-to-pregnancy approach was employed to estimate the period prevalence of 12 months, following the clinical definition (6 months for women aged 35 and older), and 24 months, according to the epidemiologic definition of primary and secondary infertility. Multiple logistic regression applied to identify the predictors of the infertility.

Results The prevalence of 12-month primary infertility was 11.8 (95% CI: 10.9, 12.8), and for 24-month primary infertility, it was 6.9 (95% CI: 6.4, 7.3). Additionally, the prevalence of 12-month secondary infertility was 15.7 (95% CI: 13.6, 18.0), and for 24-month secondary infertility, it was 9.0 (95% CI: 7.5, 10.8).

Conclusions In this study, the 12 and 24-month prevalence of primary infertility and secondary infertility has been estimated for Iran, and the provinces have been categorized as low, middle, middle-up, and high according to the estimated prevalence. These measures are crucial for health managers to tailor interventions and allocate health resources based on the actual needs of the population, enabling more effective planning in each province.

Keywords Cross-sectional studies, Infertility, Iran, Primary infertility, Secondary infertility, Time-to-pregnancy

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Introduction

Infertility, defined as the inability to conceive after 12 months or more of unprotected intercourse, poses a significant challenge for both health systems and couples. It carries a substantial social and economic burden and profoundly affects the well-being of couples [1]. Globally, it is estimated that approximately 50 million couples grapple with infertility [2]. A recently published meta-analysis reported lifetime and period prevalence of 12-month infertility at 17.5% and 12.6%, respectively [3]. World Health Organization has estimated lifetime and period prevalence of infertility to be 17.5 and 12.6, respectively [4]. Various factors contribute to infertility, including a woman's age, ovulation issues such as polycystic ovary syndrome, blocked or damaged fallopian tubes, and male factors [5–8].

Understanding the prevalence of infertility among couples is essential for health service planners to develop effective preventive measures. However, this area faces numerous challenges, including methodological variations and differences in study populations, which limit comparisons between settings or the ability to follow trends over time [3, 9, 10].

Various approaches exist for estimating the prevalence of infertility. The prospective time-to-pregnancy approach necessitates a cohort design and follows participants throughout unprotected intercourse [11, 12]. Alternatively, to estimate infertility, some researchers employ a retrospective time-to-pregnancy approach, a duration-based method, by asking participants to recall the time spent attempting pregnancy [13–16]. Another duration-based approach is the current duration approach, designed on a sample of participants at risk of pregnancy [17–20]. Direct and indirect approaches are also popular [21–24]. In the direct approach, participants report difficulties in conceiving, while in the indirect approach, infertility measures are constructed based on a series of questions.

Previous studies conducted in Iran utilized different methods and heterogeneous samples [25–28]. Some were limited to a small part of the provinces. Rostami and associates surveyed just four provinces and estimated lifetime and current prevalence of primary infertility as 21.1 and 6.4%, respectively [26]. The most recent nationwide study was conducted over a decade ago [25]. In addition, it is limited to just primary infertility in a sample of 20 and 40 years Iranian women and based on the use of contraceptives. The Total Fertility Rate has fallen below the replacement level since the early 2000s according to the World Bank website [29]. Therefore, fertility, one of the primary components of population dynamics, has gained significant importance for policymakers and healthcare bodies in population management.

Given the importance of comprehending the clinical needs of individuals and couples grappling with infertility, this study has been designed to (a) estimate the period prevalence of 12 and 24-month primary infertility among Iranian women in the fertility age period, (b) estimate corresponding secondary infertility, and (c) identify provinces with a high prevalence of primary or secondary infertility rates [5].

Methods

Study design

This population-based cross-sectional study conducted in 2019, spanning from November to December, encompassing all provinces in Iran. Iran is divided into 31 provinces and Tehran is the capital city. Participants were selected from all the 31 provinces.

Sample size

Previous studies found the prevalence of either 12-month or 24-month primary or secondary infertility to be 20.0% [25]. Using a 0.05 alpha level and an error level of 0.024, the estimated sample size was set at 1000 on average for each province. Considering the variation in population density between provinces, the sample size was determined as 700 for provinces with a population of less than 1,500,000 people, 1000 for provinces with a population between 1,500,000–3,000,000 people, and 1500 for provinces with a population of more than 3,000,000 people. Table 1 presents the list of provinces.

Setting

The main study conducted in all provinces, commencing simultaneously across the nation in November 2019 and concluding in December. Iran is divided into 31 provinces. Since each province consists of several districts,

Table 1 Sample size in each of the prevalence of infertility in Iran in 2020

subgroup	Sample size	provinces
Less than 1,500,000	700	Ardabil, Bushehr, Chaharmahal and Bakhtiari, Ilam, Kohgiluyeh and Boyer Ahmad, Markazi, North Khorasan, Qazvin, Qom, Semnan, South Khorasan, Yazd, Zanjan
Between 1,500,000 and 3,000,000	1000	Alborz, Gilan, Golestan, Hamadan, Hormozgan, Kermanshah, Kurdistan, Lorestan, Sistan Baluchistan
More than 3,000,000	1500	East Azerbaijan, Fars, Isfahan, Kerman, Khuzestan, Mazandaran, Razavi Khorasan, Tehran, West Azerbaijan
Total	31,500	-

each including a local center referred to as the capital, four districts were randomly selected in each province. In total, 121 districts of 31 provinces were selected.

Participants

Eligibility criteria

To estimate the period prevalence of 12-month infertility (clinical definition), Iranian married women currently in the union, aged 15 to 49, with a history of at least one year of cohabitation, were eligible to participate in the study. The period of cohabitation was considered to be six months for women aged 35 and older at the time of the study. For estimating the period prevalence of 24-month infertility (epidemiologic definition), the eligible duration of cohabitation was set at two years. Widowed and divorced women were excluded from this analysis (Fig. 1).

Sampling procedure

Participants were selected through multistage cluster sampling, with each province treated as a stratum. Four districts were selected in each province, and the number of participants in each province was chosen proportionally to the population size of each districts according to the latest census. Additionally, within each districts, the number of participants was selected proportionally to the population size of districts (urban) and sub-districts (rural settlements). In urban areas, census blocks were designated clusters, while "Abadies" were identified as clusters in rural areas. An Abadi is a cluster of rural

households representing the smallest part of rural areas. Within each cluster, ten eligible women were recruited.

Data were collected through face-to-face interviews conducted by trained midwives at the entrance of each household. The data collection timeframe was from 9:00 to 13:00 in the morning and from 15:00 to 18:00. Only one eligible woman per household was recruited, and if there were more than one eligible woman, one was selected via simple random sampling. It was skipped if there were no eligible or willing participants in the household. In cases where no one was available to answer, or the eligible woman was absent, the interviewer had to make two additional attempts. If the number of participants in the primary cluster did not reach 10, sampling continued from the nearest block or village to reach that target.

Variables

The questionnaire used in this study developed for this study. (It administrated in Persian but an English language version is available in supplement 1). Since there is no standardized questionnaires to measure the infertility. The questionnaire developed to collect some information in order to use retrospective time to pregnancy approach to measure the infertility. Some detail addressed. The questionnaire comprised three parts. The first part included demographic information about the woman and her spouse, covering age, age at marriage, marital status, education level, and insurance. In the second part, data on the woman's marital history were collected, including the duration of cohabitation, the number of pregnancies

Fig. 1 Approaches of infertility measure for period prevalence of primary and secondary 12 and 24 months infertility in Iranian couples

(confirmed pregnancies, not just childbirths), the number of living children, and the duration of pregnancy. The third part included data on the woman's age at every pregnancy she had experienced, whether the pregnancy was planned or not, time to pregnancy (categorized as: less than six month, six months to one year, one to two years, two to five years, and more than five years) and the outcome of each pregnancy. The outcomes included being pregnant at the time of the interview, live birth, stillbirth (fetal deaths at ≥ 20 weeks of gestation), intra-uterine death, abortion (decision to end a pregnancy or spontaneous loss of a pregnancy, miscarriage), ectopic pregnancy, and molar pregnancy. Additionally, the final question addressed the decision to get pregnant after the birth of the last child. If the participant attempted to get pregnant, the age at that time and the duration were recorded.

Self-reported laboratory-confirmed pregnancies were considered valid, and data on each variable were collected for each reported pregnancy.

Across the 31 provinces in Iran, risk categories defined based on the prevalence of both primary and secondary infertility. After estimating the infertility prevalence, primary and secondary, we categorized the provinces into four distinct categories including low prevalence, middle, middle-up, and high prevalence.

The approach of infertility measure

The retrospective time-to-pregnancy approach was applied to estimate the period prevalence of primary and secondary infertility based on the 12 or 24 months of unsuccessful attempts at pregnancy. The definitions of the measures were as follows:

1. Primary infertility

   - *12- month period prevalence of primary infertility (clinical definition)*:

     - Among couples without a history of pregnancy, inability to conceive after 12 months of unprotected intercourse for women aged < 35, or after six months for women aged > 35 years old.
     - For women with a history of pregnancy, pregnancy for the first time after 12 months of unprotected intercourse for women aged < 35 years or after six months for women aged > 35 years old.

   - *24- month period prevalence of primary infertility (epidemiologic definition)*:

     - Among couples without a history of pregnancy, inability to conceive after 24 months of unprotected intercourse.
     - For the women with a history of pregnancy, pregnancy for the first time after 24 months of unprotected intercourse from the time of conception, for the first pregnancy.

2. Secondary infertility

   - *12- month period prevalence of secondary infertility (clinical definition)*:

     - Among couples with a history of at least one pregnancy, inability to conceive after 12 months of unprotected intercourse, which considered six months in the case of women 35 years old and older.

   - *24-Month period prevalence of secondary infertility (epidemiologic definition)*:

     - Among couples with a history of at least one pregnancy, inability to conceive after 24 months of unprotected intercourse.

Fig. 1 illustrates different approaches to measure the burden of infertility in Iranian women.

Statistical methods

The prevalence was estimated by applying weights to take into account sampling weights. To adjust the estimated prevalence, we utilized the svyset command in Stata 14.2, considering both the sampling weight and sampling scheme.

For this purpose, two sampling levels were determined, and the specifications of these levels were as follows: in two levels, we defined counties and their selected postal codes as clusters, and the provinces and districts as strata.

Sampling weights were the reverse of sampling fractions of eligible women in each level.

Univariate logistic regression applied to determine the predictors of primary and secondary infertility and all the variables were included in the adjusted model. The multivariable logistic regression model (adjusted model) used to identify the independent predictors of infertility at a significance level of 0.05.

Results

Of 30,405 participants, 30,269 were eligible for analysis in the present study (Fig. 2). The mean age (SD) of the participants was 35.73 (7.3), and the majority of them (78.2%) were living in urban areas. 6% had no history of pregnancy. The mean number of pregnancies (SD) was
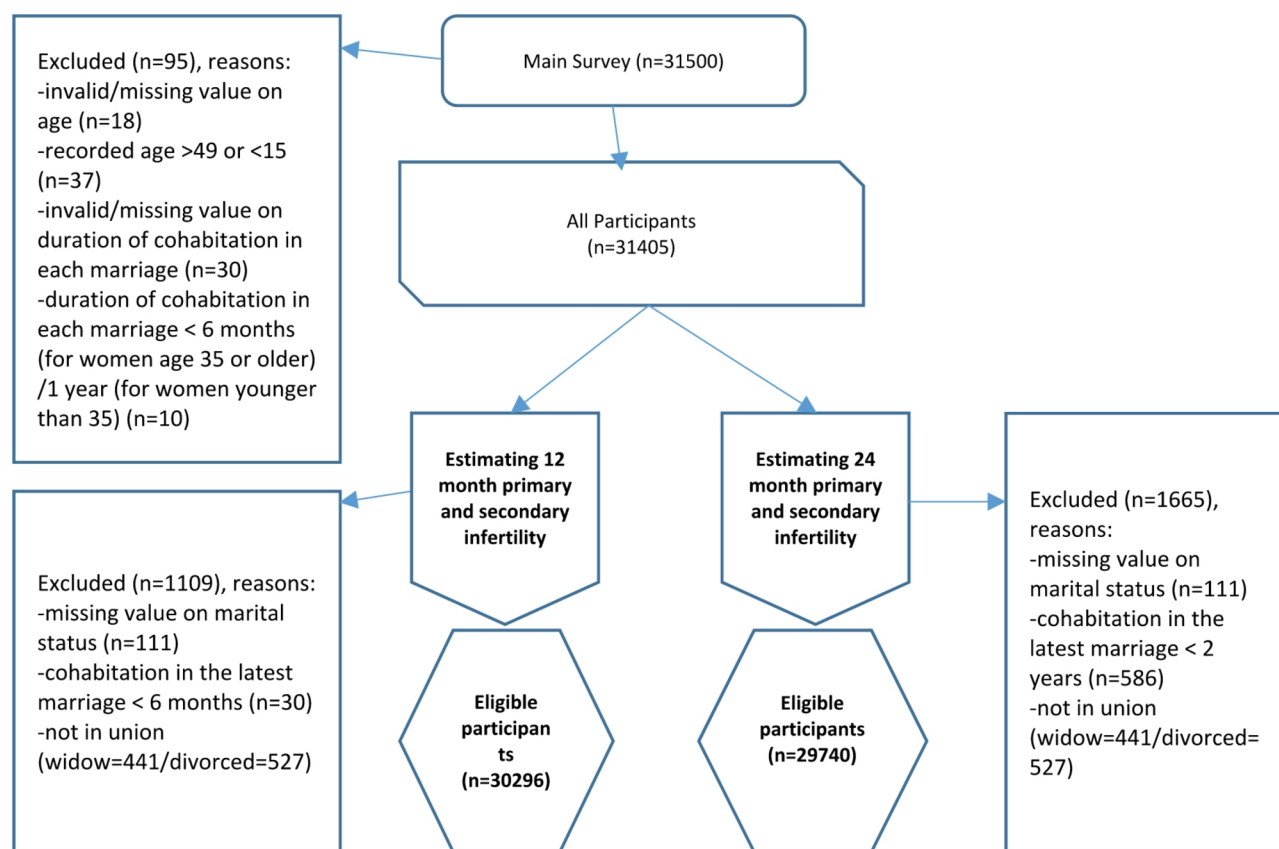
Fig. 2 Flow diagram of the eligible participants for estimating 12 and 24 months period prevalence of primary and secondary infertility in Iran in 2019

2.4 (1.4), and the mean age at first pregnancy (SD) was 22.7 (4.8). Table 2 presents the demographic characteristics of the study population by location.

The prevalence of 12-month primary infertility was 11.8 (CI 95%: 10.9, 12.8). The prevalence was higher among those who lived in rural areas and women who were illiterate or had primary education (Table 3). In each of the age groups, the prevalence was higher in rural women. The prevalence of 24-month primary infertility was 6.9 (CI 95%: 4.6, 7.3). It was higher among women who lived in rural areas and women with lower years of schooling (Table 3).

On the other hand, the prevalence of 12-month secondary infertility was 15.7 (CI 95%: 13.6, 18.0). The prevalence was higher among women who lived in rural areas, women with up to five years of schooling, with a history of abortion, and a history of repetitive abortion (Table 4). Additionally, the prevalence of 24-month secondary infertility was 9.0 (CI 95%: 7.5, 10.8). It was higher among women who lived in rural areas, women who were illiterate or had primary education, with a history of abortion, and a history of repetitive abortion (Table 4).

According to the adjusted model, no statistically significant association existed between age and 12-month primary infertility. In addition, compared to low-educated women, the odds of primary infertility were 30% (AOR: 0.70, CI 95%: 0.62, 0.80) and 21% (AOR: 0.79, CI 95%: 0.71, 0.88) lower in women with a more than 12 years of schooling and with 12 years of schooling, respectively. The odds of 12-month primary infertility were 21% higher in rural areas (AOR: 1.21, CI 95%: 1.08, 1.36) (Table 5). According to the adjusted model, 24-month primary infertility odds was significantly higher in women with lower education (Table 5).

In the adjusted model, secondary infertility was inversely associated with education. In addition, a history of abortion as well as a history of repetitive abortion increased the risk of 12-months secondary infertility by 37% (AOR: 1.37, CI 95%: 1.15, 1.64) and 35% (AOR: 1.35, CI 95%: 1.15, 1.59), respectively (Table 6). The odds of 24-month secondary infertility significantly increased in the presence of a positive history of abortion and repetitive abortion. In addition, it was inversely associated with education (Table 6).

Discussion

Fertility and the ability to have children have always been concerns for couples. Today, the problem of infertility is one of the most significant challenges to population health. This study designed to estimate the period

Table 2 Demographic characteristics of the study population by location for estimating 12 and 24 months period prevalence of primary and secondary infertility in Iran in 2019

Variables	Subgroups	Urban area, *N* (%)	Rural area, *N* (%)
Age groups	15–24 years	1408 (5.9)	677 (10.2)
	25–29 years	3201 (13.5)	1092 (16.5)
	30–34 years	5316 (22.4)	1497 (22.6)
	35–39 years	5812 (24.5)	1372 (20.7)
	40–44 years	4595 (19.4)	1164 (17.6)
	45–49 years	3350 (14.1)	812 (12.3)
Number of pregnancies	0	1507 (6.4)	333 (5.0)
	1	5399 (22.8)	1222 (18.5)
	2	8429 (35.6)	2057 (31.1)
	3	4963 (20.9)	1529 (23.1)
	4 and more	3380 (14.0)	1472 (22.0)
Mean age at first pregnancy (SD)		23.01 (4.8)	21.69 (4.6)
Years of Formal education	0 year	488 (2.1)	547 (8.3)
	1–5 years	3201 (13.5)	2340 (35.4)
	6–11 years	3401 (14.4)	1467 (22.2)
	12 years Diploma	9484 (40.1)	1791 (27.1)
	13 years and more	5587 (23.6)	413 (6.2)
	Bachelor and higher	1481 (6.3)	50 (0.8)
Health Insurance coverage	No	2582 (10.9)	192 (2.9)
	Yes	21,023 (89.1)	6389 (97.1)

Table 3 Period prevalence and 95% confidence interval of 12-month and 24-month primary infertility among 15-49-year-old Iranian women

Variables	Subgroups	Primary infertility, (CI 95%)					
		Total		Urban		rural	
		12-month	24-month	12-month	24-month	12-month	24-month
Total		11.8 (10.9, 12.8)	6.9 (6.4, 7.3)	11.2 (10.4, 12.1)	6.6 (6.2, 7.0)	14.5 (12.9, 16.2)	8.2 (7.3, 9.2)
Age groups	15–24 years	12.5 (9.9, 15.6)	6.7 (5.0, 8.9)	11.2 (8.4, 14.9)	6.2 (4.3, 8.8)	15 (11.6, 19.3)	7.7 (5.4, 11.0)
	25–29 years	11.4 (10.3, 12.6)	6.9 (6.3, 7.6)	10.5 (9.4, 11.8)	6.5 (5.8, 7.3)	14.2 (11.8, 16.9)	8.1 (6.6, 9.9)
	30–34 years	10.8 (9.6, 12.1)	6.0 (5.4, 6.7)	10.1 (9.0, 11.4)	5.8 (5.1, 6.5)	13.7 (11.4, 16.4)	6.8 (5.5, 8.3)
	35–39 years	12.8 (12.1, 13.6)	7.5 (6.9, 8.3)	12.3 (11.5, 13.1)	7.1 (6.4, 7.9)	15.6 (13.6, 17.7)	9.5 (7.8, 11.4)
	40–44 years	11.9 (10.6, 13.4)	7.3 (6.6, 8.2)	11.6 (10.2, 13.0)	7.1 (6.4, 7.9)	13.5 (11, 16.5)	8.3 (6.4, 10.6)
	45–49 years	11.9 (10.6, 13.3)	6.7 (6.0, 7.6)	11.2 (10.1, 12.3)	6.2 (5.5, 7.0)	15.6 (12.0, 20.0)	9.3 (7.2, 11.9)
Years of Formal education	0–5 years	14.4 (12.8, 16.1)	8.5 (7.7, 9.4)	12.9 (11.4, 14.5)	8.1 (7.3, 9.0)	16.4 (14.3, 18.9)	9.1 (7.9, 10.5)
	6–11 years	13.5 (12.3, 14.7)	7.8 (6.8, 9.0)	12.9 (11.7, 14.2)	7.4 (6.2, 8.9)	14.8 (12.8, 17.1)	8.6 (7.2, 10.3)
	12 years	11.2 (10.5, 12.0)	6.8 (6.3, 7.4)	11.2 (10.3, 12.1)	6.8 (6.2, 7.4)	11.4 (9.9, 13.2)	6.8 (5.4, 8.5)
	More than 12	10.0 (9.1, 10.9)	5.3 (4.7, 6.1)	9.7 (8.9, 10.7)	5.2 (4.5, 5.9)	13.4 (10.6, 16.9)	7.3 (5.1, 10.3)
Risk category	Low[1]	9.6 (9.0, 10.2)	5.7 (5.0, 6.7)	9.5 (8.8, 10.2)	5.7 (4.9, 6.6)	10.4 (8.3, 13.1)	6.2 (4.5, 8.5)
	Middle[2]	11.7 (10.8, 12.6)	6.8 (6.3, 7.5)	10.9 (10.2, 11.6)	6.4 (6.0, 6.9)	14.3 (12.7, 16)	8.2 (6.8, 9.9)
	Middle up[3]	11.7 (10.7, 12.9)	6.4 (5.7, 7.3)	11.8 (11.1, 12.6)	6.4 (5.9, 7.1)	11.5 (8.6, 15.3)	6.5 (4.6, 8.9)
	High[4]	15.8 (13.0, 19.1)	9.4 (8.2, 10.4)	14.5 (12, 17.5)	8.7 (7.7, 9.8)	19.8 (16.1, 24.2)	11 (9.6, 12.7)

1. Low prevalence: Gillan, Markazi, Alborz, Zanjan, Ghazvin, Esfahan, Tehran

2. Middle prevalence: East Azarbaijan, Mazandaran, Fars, Kerman, Hamedan, Kurdistan, Yazd, South Khorasan

3. Middle-up prevalence: Khorasan Razavi, Western Azerbaijan, Lorestan, Chaharmahal Bakhtiari, Qom, Ilam, North Khorasan, Semnan

4. High prevalence: Khuzestan, Hormozgan, Sistan and Baluchistan, Golestan, Kermanshah, Ardabil, Bushehr, Kohgiluyeh and Boyer Ahmad

prevalence of 12 and 24-month primary and secondary infertility in Iranian women of reproductive age using the retrospective time-to-pregnancy (TTP) approach. According to the findings of the present study, approximately 12% of Iranian women have experienced 12-month primary infertility, ranging from 9.6 to 15.8% across provinces. Additionally, 24-month primary infertility was around 7%, ranging from 5.7 to 9.3% across the country. About 16% of women are experiencing 12-month secondary infertility, ranging from 12.2 to 21.2%. Finally, 9% of women are experiencing 24-month

Table 4 Period prevalence and 95% confidence interval of 12-month and 24-month secondary infertility among 15-49-year-old Iranian women

Variables	Subgroups	Secondary infertility, (CI 95%)					
		Total		Urban		Rural	
		12-month	24-month	12-month	24-month	12-month	24-month
Total		15.7 (13.6, 18.0)	9.03 (7.5, 10.8)	15.0 (12.8, 17.5)	8.6 (7.1, 10.5)	19.0 (16.0, 22.5)	10.7 (8.5, 13.4)
Age groups	**15–24 years**	16.1 (11.5, 22.1)	7.6 (5.0, 11.6)	14.8 (10.3, 20.8)	7.1 (4.4, 11.3)	18.6 (11.8, 28.2)	8.6 (5.0, 14.2)
	25–29 years	11.7 (8.9, 15.1)	6.4 (4.5, 8.9)	10.8 (7.5, 15.1)	6 (3.9, 9.1)	14.1 (10.5, 18.6)	7.4 (4.9, 11.1)
	30–34 years	13.0 (10.7, 15.8)	8.2 (6.4, 10.5)	12.1 (9.7, 15.0)	7.5 (5.9, 9.7)	16.2 (12.4, 20.9)	10.6 (7.4, 14.8)
	35–39 years	17.4 (15.2, 19.9)	10 (8.4, 12.0)	16.3 (14.0, 19.1)	9.4 (7.7, 11.4)	22.4 (18.6, 26.6)	12.9 (10.0, 16.4)
	40–44 years	17.9 (15.6, 20.5)	10.2 (8.9, 11.8)	17.2 (15.0, 19.8)	9.9 (8.5, 11.5)	21.1 (17.4, 25.5)	11.8 (9.3, 14.9)
	45–49 years	15.7 (13.3, 18.5)	8.9 (7.3, 11.0)	14.9 (12.5, 17.8)	8.7 (6.9, 10.8)	19.7 (15.4, 24.8)	10 (7.3, 13.5)
Years of Formal education	**0–5 years**	20.0 (16.3, 24.2)	12.1 (9.4, 15.5)	18.6 (14.3, 23.9)	11.7 (8.7, 15.5)	21.9 (17.9, 26.5)	12.7 (9.6, 16.5)
	6–11 years	15.9 (13.9, 18.2)	9.8 (8.4, 11.5)	15.2 (12.7, 18.1)	9.8 (8.1, 11.6)	18.2 (14.2, 23.0)	9.8 (7.3, 13.1)
	12 years	14.2 (12.5, 16.1)	8.4 (7.2, 9.7)	14.1 (12.2, 16.2)	8.3 (7.0, 9.8)	14.8 (11.9, 18.1)	8.5 (6.6, 10.8)
	More than 12 years	13.8 (12.1, 15.7)	6.5 (5.0, 8.5)	13.7 (11.9, 15.7)	6.5 (4.9, 8.6)	15.1 (11.1, 20.0)	6.3 (3.9, 9.9)
Abortion	**No**	14.1 (11.8, 16.8)	8.2 (6.6, 10.1)	13.2 (10.8, 16)	7.7 (6.1, 9.8)	17.6 (14.1, 21.8)	9.8 (7.3, 13.1)
	Yes	19.4 (17.3, 21.6)	11.0 (9.6, 12.6)	18.7 (16.4, 21.2)	10.6 (9.2, 12.2)	22.4 (19.3, 25.9)	12.9 (10.6, 15.6)
Repetitive abortion	**No**	15.0 (12.9, 17.4)	8.7 (7.2, 10.5)	14.1 (12.0, 16.6)	8.2 (6.7, 10.1)	18.5 (15.2, 22.2)	10.5 (8.1, 13.4)
	Yes	23.0 (20.3, 26.0)	12.9 (10.9, 15.3)	22.6 (19.6, 26.0)	12.7 (10.5, 15.4)	24.7 (20.4, 29.7)	13.5 (10, 18.1)
Risk category	**Low[1]**	12.2 (11. 1, 13.3)	6.5 (5.7, 7.3)	12.0 (10.9, 13.2)	6.3 (5.5, 7.1)	14.2 (10.6, 18.8)	8.6 (6.4, 11.5)
	Middle[2]	13.3 (11.5, 15.3)	7.0 (6.2, 7.8)	12.6 (10.6, 14.9)	6.9 (6.0, 7.9)	15.5 (12.6, 19.0)	7.3 (5.8, 9.1)
	Middle up[3]	18.4 (16.5, 20.6)	10.7 (9.0, 12.2)	18.4 (17.0, 19.9)	10.9 (9.4, 12.6)	18.6 (12.6, 26.7)	10 (6.5, 15.1)
	High[4]	21.2 (13.8, 31.2)	13.8 (8.5, 21.5)	19.7 (11.8, 31)	12.9 (7.4, 21.3)	25.8 (18.2, 35.1)	16.5 (10.5, 25.1)

1. Low prevalence: Gillan, Markazi, Alborz, Zanjan, Ghazvin, Esfahan, Tehran

2. Middle prevalence: East Azarbaijan, Mazandaran, Fars, Kerman, Hamedan, Kurdistan, Yazd, South Khorasan

3. Middle-up prevalence: Khorasan Razavi, Western Azerbaijan, Lorestan, Chaharmahal Bakhtiari, Qom, Ilam, North Khorasan, Semnan

4. High prevalence: Khuzestan, Hormozgan, Sistan and Baluchistan, Golestan, Kermanshah, Ardabil, Bushehr, Kohgiluyeh and Boyer Ahmad

Table 5 Crude and adjusted odds ratios and 95% confidence intervals associations for demographic and clinical factors and the prevalence of 12-month and 24-month primary infertility among 15-49-year-old Iranian women

Variables	Subgroups	Primary Infertility			
		12-month		24-month	
		Crude Odds Ratio (CI 95%)	Adjusted Odds Ratio (CI 95%)	Crude Odds Ratio (CI 95%)	Adjusted Odds Ratio (CI 95%)
Age groups	**15–24 years**	ref	ref	ref	ref
	25–29 years	0.91 (0.73, 1.14)	0.96 (0.76, 1.21)	1.04 (0.76, 1.42)	1.12 (0.82, 1.53)
	30–34 years	0.86 (0.68, 1.07)	0.92 (0.74, 1.15)	0.9 (0.66, 1.21)	0.98 (0.72, 1.32)
	35–39 years	1.04 (0.79, 1.37)	1.12 (0.84, 1.5)	1.14 (0.82, 1.6)	1.24 (0.87, 1.77)
	40–44 years	0.96 (0.77, 1.19)	0.99 (0.80, 1.23)	1.11 (0.84, 1.47)	1.15 (0.86, 1.53)
	45–49 years	0.95 (0.76, 1.19)	0.95 (0.76, 1.19)	1.01 (0.75, 1.37)	1.00 (0.74, 1.37)
Years of Formal education	**0–5 years**	ref	ref	ref	ref
	6–11 years	0.93 (0.81, 1.07)	0.95 (0.83, 1.10)	0.91 (0.77, 1.07)	0.93 (0.79, 1.08)
	12 years	0.76 (0.68, 0.85)	0.79 (0.71, 0.88)	0.79 (0.69, 0.90)	0.81 (0.72, 0.91)
	More than 12 years	0.66 (0.58, 0.76)	0.7 (0.62, 0.80)	0.61 (0.51, 0.72)	0.63 (0.53, 0.75)
Location	**Urban**	ref	ref	ref	ref
	rural	1.35 (1.17, 1.55)	1.21 (1.08, 1.36)	1.28 (1.12, 1.46)	1.13 (1.00, 1.28)

secondary infertility, which ranges from 6.5 to 13.8% across Iran.

Some provinces, like Sistan and Baluchestan, which have high birth rates, also exhibit a high prevalence of infertility. This phenomenon can be explained by the demographic paradox known as 'barrenness amid plenty,'

signifying the coexistence of high rates of infertility with high rates of fertility [30].

In this study, the estimated prevalence of infertility was higher than reported by Safarinejad et al. and lower than the estimation by Akhondi et al. It also differs from the results of the study conducted by Vahidi et al. [25, 27,

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Table 6 Crude and adjusted odds ratios and 95% confidence intervals associations for demographic and clinical factors and the prevalence of 12-month and 24-month secondary infertility among 15-49-year-old Iranian women

Variables	Subgroups	Secondary infertility			
		12-month		24-month	
		Crude Odds Ratio (CI 95%)	Adjusted Odds Ratio (CI 95%)	Crude Odds Ratio (CI 95%)	Adjusted Odds Ratio (CI 95%)
Age groups	15–24 years	ref	ref	ref	ref
	25–29 years	0.69 (0.53, 0.91)	0.72 (0.54, 0.96)	0.83 (0.61, 1.13)	0.88 (0.64, 1.21)
	30–34 years	0.79 (0.58, 1.07)	0.83 (0.59, 1.16)	1.09 (0.77, 1.55)	1.19 (0.81, 1.75)
	35–39 years	1.10 (0.78, 1.56)	1.16 (0.80, 1.69)	1.36 (0.93, 1.97)	1.48 (0.99, 2.22)
	40–44 years	1.15 (0.80, 1.65)	1.15 (0.78, 1.71)	1.39 (0.93, 2.07)	1.42 (0.92, 2.19)
	45–49 years	0.98 (0.70, 1.37)	0.96 (0.66, 1.39)	1.20 (0.80, 1.78)	1.16 (0.75, 1.81)
Years of Formal education	0–5 years	ref	ref	ref	ref
	6–11 years	0.76 (0.64, 0.91)	0.8 (0.66, 0.98)	0.79 (0.65, 0.96)	0.81 (0.65, 1.02)
	12 years	0.67 (0.56, 0.80)	0.71 (0.57, 0.88)	0.66 (0.55, 0.80)	0.67 (0.53, 0.85)
	More than 12 years	0.64 (0.53, 0.78)	0.68 (0.53, 0.87)	0.51 (0.37, 0.69)	0.50 (0.35, 0.71)
Location	Urban	ref	ref	ref	ref
	rural	1.34 (1.05, 1.71)	1.23 (0.93, 1.63)	1.28 (0.98, 1.67)	1.09 (0.82, 1.45)
Abortion	No	ref	ref	ref	ref
	Yes	1.47 (1.27, 1.70)	1.37 (1.15, 1.64)	1.40 (1.22, 1.61)	1.34 (1.14, 1.57)
Repetitive abortion	No	ref	ref	ref	ref
	Yes	1.70 (1.52, 1.90)	1.35 (1.15, 1.59)	1.56 (1.30, 1.87)	1.27 (1.03, 1.56)

28]. Aside from the differences in the age composition of the populations under investigation and potential time trends in infertility prevalence, the main reason for these variations could be the differences in the approaches used to estimate infertility in these studies [9, 10]. This study is among the few in Iran where infertility defined based on the time between the intention to conceive and the occurrence of pregnancy, considering the female age. The time-to-pregnancy approach employed to estimate the prevalence of infertility, as widely recommended in the literature [3, 9, 31].

The differences in methodology and study settings make direct comparisons between the results of the present study and others across the world challenging. For instance, a study conducted by Bello et al. in South Africa reported 12- and 24-month infertility rates as 32% and 17%, respectively, which are higher than the results of the present study [32]. Bach et al. found a 12-month prevalence of primary infertility at 21% in their study [33]. In the Netherlands, the period prevalence of primary infertility has been estimated as 16.7% [16]. Another study on pregnant women in Sweden reported a 12-month period prevalence of infertility as 9.7% [13] and Chen et al. in China reported the period prevalence of primary infertility as 11.97% [34]. Bell and associates by current duration approach estimated an overall 12-month infertility prevalence of 7.9% in Burkina Faso, 29.6% in Côte d'Ivoire, 24.5% in Kenya, and 14.7% in Uganda [32]. Comparing to the neighbors, WHO estimated period prevalence of infertility is highest in the WHO African Region which is 16.4% and the lowest in the Eastern Mediterranean Region including Iran. Our estimates for prevalence of 12-month primary infertility was near to the reported by WHO for Eastern Mediterranean Region which is 10% [4].

The present study observed a higher prevalence of secondary infertility compared to primary infertility for both the 12- and 24-month duration, a finding consistent with results reported in Spain, China, Ukraine, and some other parts of the world, as cited by Gurunath et al. [9, 14, 35, 36]. However, it's worth noting that Safarinejad et al. reported a higher prevalence of secondary infertility, similar to a study conducted in the north of Scotland [27, 37].

Primary infertility in this study was significantly influenced by the level of education and residing in rural areas. Interestingly, while many studies commonly identify increasing age as a risk factor for infertility, this study did not find a statistically significant association [37, 38]. The protective effect of education on infertility is consistent with findings from other research [39]. This may due to better access to the resources and higher socioeconomic status.

The variations in reported figures within Iran and globally can be attributed to diverse factors [3]. Beyond differences in the studied populations, the varying approaches used to define infertility contribute significantly to the disparities in reported figures worldwide. The absence of a consensus on a standardized definition makes estimating prevalence challenging for health service planning. To comprehensively study the trend of infertility in Iran,

conducting repeated studies using uniform approaches is highly recommended.

This cross-sectional, population-based study has inherent limitations common to such designs, particularly in establishing causal inferences. The study is designed to estimate infertility using a retrospective Time to Pregnancy (TTP) approach, and cultural considerations led to relying solely on women's reports. The results are based on the self reported data and this may introduce recall biases. To address recall limitations, questions about time to pregnancy were structured categorically, restricting the use of Cox models. In addition, efforts were made to mitigate recall bias by allowing sufficient time for participants to remember their pregnancy history. The study faced resource constraints, preventing the collection of anthropometric data. Additionally, the small sample size in each province limits the precision of point estimates and related confidence intervals. To address this limitation, provinces were categorized based on measures, and prevalence within each category was reported. period of cohabitation Allocating more resources to those provinces with higher prevalence to improve reproductive health is highlighted.

A considerable number of women have encountered infertility, emphasizing the importance of identifying its risk factors and developing preventive interventions to enhance reproductive health for both women and men. Initiatives such as screening young couples for infertility risk factors and increasing public awareness that play a vital role in the early detection and management of infertility cases are highly recommended. On the other hand based on the present study the prevalence of infertility less-educated and rural populations, which calls on specific interventions targeting these subgroups.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22974-z.

Supplementary Material 1

Declarations

Ethics approval and consent to participate
The Iran National Institute for Health Research Ethics Committee reviewed and approved the study protocol with the registration code IR.TUMS.NIHR.REC.1397.010. The study was conducted in accordance with the declaration of Helsinki. Before commencing the interview, the interviewers described the aim of the study. All the participants assured that participation in the study was voluntary and their information would remain confidential with the research team. All participants provided signed written informed consent. For female participants under 16, verbal informed consent was also obtained from their legal guardians.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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