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Trends of Multiple Births in Iran from 2014 to 2023

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Abstract

Background: The aim of this study was to analyze the trends of multiple births at both national and provincial levels in Iran from 2014 to 2023.

Methods: Data on the number of live births and multiple births from 2014 to 2023 at national and provincial levels were obtained from the Iran's Bureau of Vital Statistics. The multiple birth rate (MBR), defined as the number of live births from multiple births per 1,000 live births, was calculated annually. To examine temporal trends and detect significant changes in MBR over the study period, joinpoint regression analysis was performed. Annual percent change (APC) and average annual percent change (AAPC) were calculated for the entire period.

Result: The national AAPC in the MBR was estimated at 2.38% (95%CI: 1.95 to 2.76) over the entire study period. A significant shift in trend was identified in 2020. Specifically, the APC from 2014 to 2020 was 0.24%. However, from 2020 to 2023, the APC markedly increased to 6.8%, reflecting a substantial rise in MBR during this latter period. Furthermore, the study findings demonstrated that nearly all provinces across the country have exhibited an upward trend in MBR in recent years.

Conclusion: The increasing trend of multiple births in Iran aligns with global patterns. Several factors may have contributed to this rise, including increased maternal age at childbirth, higher prevalence of infertility, expanded use of assisted reproductive technologies (ARTs), and shifts in population policies.

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Introduction

Multiple births, defined as the delivery of more than one infant, are associated with an elevated risk of adverse perinatal outcomes and are classified as high-risk pregnancies (1). These deliveries are correlated with a heightened incidence of major obstetric complications (2). Complications associated with this type of pregnancy include maternal and fetal mortality during gestation and delivery, spontaneous abortion, fetal growth restriction, preeclampsia, hydramnios, preterm birth, maternal hemorrhage, increased risk of pregnancy-induced hypertension, gestational diabetes, higher incidence of preterm birth, abnormal fetal growth, and birth trauma (3-7). These births are associated with substantially higher healthcare costs compared to singleton deliveries (8).

The global incidence of multiple births has demonstrated an increasing trend since 1970 (9). The rising social trend of delayed childbearing, resulting in increased maternal age, alongside advancements in ARTs, contributes to the global increase in multiple births (2). Fertility treatments

primarily encompass in vitro fertilization (IVF), intracytoplasmic sperm injection (ICSI), as well as non-IVF/ICSI methods (2). The most common adverse outcome associated with IVF treatment is multiple pregnancies (8).

Iran is a country that, in addition to experiencing an increase in maternal age, has been facing a low birth rate, particularly in recent years. This declining trend, coupled with an aging population, has raised significant concerns regarding the country's demographic future. In recent years, especially following the COVID-19 pandemic, comprehensive policies to support childbearing have been implemented in Iran. One such policy involves facilitating infertility treatment processes, which has the potential to influence the trends of multiple births.

The aim of this study was to conduct a comprehensive analysis of the trend of multiple births at both national and provincial levels in Iran from 2014 to 2023, with a focus on examining temporal alterations and identifying the specific years during which these changes occurred across different provinces.

Methods

This study was carried out across Iran and its 31 provinces during the years 2014 to 2023.The data was collected from the Iran's Bureau of Vital Statistics. The data included the number of live singleton and multiple births from 2014 to 2023 at both the national and provincial levels in Iran.

MBR, defined as the number of live multiple births per 1,000 live births, was calculated annually throughout the aforementioned period (10). To examine the temporal trend and detect significant changes in MBR between 2014 and 2023, the joinpoint regression model was employed. This model is a type of regression that divides data into discrete linear segments and identifies trend changes through connection points. The Annual Percentage Change (APC) index quantifies the yearly rate of increase or decrease over a specified period, where positive values denote an upward trend and negative values signify a downward trend.

To estimate the APC, the following model is used: $\mathrm{Log}(Y_x) = b_0 + b_1 x$ where log (Yx) is the natural logarithm of the rate in year x. Then, the APC from year x to year x + 1 is calculated as: APC= $(e^{b1} - 1) * 100$.

The average annual percentage change (AAPC) is estimated as a weighted average of the estimated APC in each segment, using the segment lengths as weights. Additionally, AAPC was calculated as a summary measure to characterize the overall trend throughout the entire study period (11). Trend analysis of multiple birth rates was conducted using Joinpoint software version 4.7.0.0, developed by the Surveillance Research Program of the National Cancer Institute, USA. APC and AAPC, along with their 95% confidence intervals and p-values, were calculated for 2014–2023 at national and provincial levels. The significance level in this study was considered to be 0.05.

The current research was approved by the ethics committee of Kerman University of Medical Sciences (IR.KMU. REC.1404.209).

Results

Overview of trends during the entire study period (2014–2023): The national AAPC during the entire period (2014-2023) was estimated at 2.38 (95% CI: 1.95–2.76). On average, the MBR increased by approximately 2.38% per annum over the entire study period. In addition, based on the AAPC, the provinces were grouped into four distinct categories. Two categories fell below the national average, defined as an AAPC of less than 1% and between 1% and 2.38% (the national average). The other two categories were above the national average, defined as AAPC values between 2.38% and 3%, and between 3% and 4%, respectively. In this study, no AAPC values greater than 4% were identified (Figure 1).

In Semnan, Qom, Ilam, and Zanjan provinces, the trend remained steadily increasing over the entire period with no specific jointpoint identified.

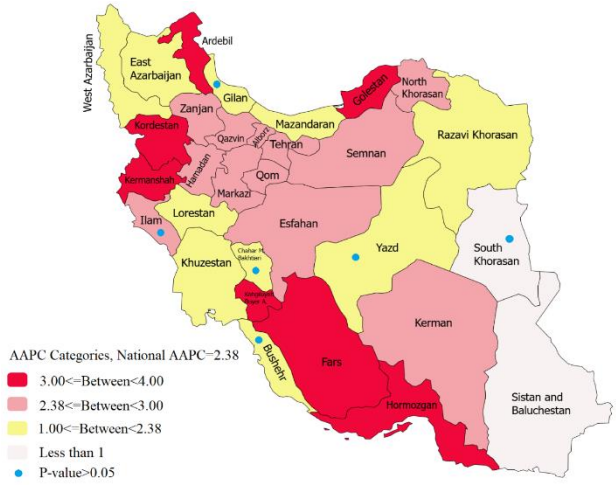

Figure 1. MBRs and their corresponding AAPC values for the period 2014–2023

This upward trend was in all of these provinces, except for Ilam province. Throughout the period from 2014 to 2023, the APC in these provinces ranged from 1.75% to 2.66%.

APC values estimated using joinpoint: Analysis of APC of MBR trends using joinpoint across various provinces revealed both significant and non-significant changes over recent years. The analysis showed that in some provinces, after a significant decline in MBR, a joinpoint was detected, indicating a subsequent upward trend. The identified joinpoints occurred within the period from 2017 to 2020.

Joinpoints identified in 2017: Between 2014 and 2017, the MBR in West Azerbaijan and Lorestan provinces exhibited a declining trend. During this period, the annual reductions in MBR were estimated at -2.35% and -3.29% for West Azerbaijan and Lorestan, respectively. Subsequently, from 2017 onwards, the MBR demonstrated upward trend, with annual growth rates of 3.88% in West Azerbaijan and 5.27% in Lorestan provinces.

Joinpoints identified in 2018: Between 2014 and 2018, the MBR in Tehran, Mazandaran, and Yazd provinces exhibited a downward trend. During this period, the estimated annual reductions were -0.83% in Tehran, -1.59% in Mazandaran, and -2.04% in Yazd. Following 2018, the MBR in these provinces showed an upward trend. The annual increases after 2018 were calculated as 5.12% for Tehran, 4.35% for Mazandaran, and 4.09% for Yazd.

Joinpoints identified in 2019: The provinces of Bushehr, East Azerbaijan, Chaharmahal and Bakhtiari, Hamedan, Isfahan, Kermanshah, and Sistan and Baluchestan experienced a change in MBR trend in the year 2019. In Bushehr and Sistan and Baluchestan provinces, the MBR followed downward trend up to 2019, with annual decrease rates of -4.2% and -1.8%, respectively. However, after 2019, both provinces experienced upward trend, with annual increases of 7.92% in Bushehr and 4.37% in Sistan and Baluchestan.

Prior to 2019, the provinces of Kermanshah, Chaharmahal and Bakhtiari, and Isfahan experienced downward trends in the MBR. The annual rates of decrease were estimated at -0.51% for Kermanshah, -1.54% for Chaharmahal and Bakhtiari, and -0.91% for Isfahan. However, after 2019, an increase in MBR was observed in all three provinces. The annual rates of increase were calculated as 8.82% for Kermanshah, 6.64% for Isfahan, and 5.09% for Chaharmahal and Bakhtiari.

Although East Azerbaijan province exhibited an upward trend in MBR prior to 2019, the province experienced an annual increase of 7.75%.

In several other provinces, changes in MBR occurred either before or after the identified joinpoint. Specifically, Hamedan province exhibited an annual decline of -0.39% prior to 2019, followed by an annual increase of 5.75% thereafter.

Joinpoints identified in 2020: At the national level, a change in the trend of MBR was observed in 2020. From 2014 to 2020, the annual change was 0.24%. However, between 2020 and 2023, the annual change increased to 6.8%, indicating a notable growth in MBR during this period.

In 2020, the provinces of Alborz, Gilan, Markazi, and South Khorasan experienced a change in MBR trend. Prior to 2020, these provinces exhibited a downward trend in MBR; however, following this year, the trend shifted to upward trajectory. The most pronounced annual decline before 2020 was observed in Markazi province, with a rate of -2.45%. After 2020, all mentioned provinces demonstrated a strong increase in MBR.

Although the provinces of Ardabil, Fars, Golestan, Khuzestan, Qazvin, and Kerman exhibited a non-significant upward trend in MBR prior to 2020, they demonstrated a strong annual increase thereafter. For instance, Kerman province's annual change rate shifted from approximately 0.002% before 2020 to 7.65% following that year. Similarly, Ardabil province experienced an increase from 0.17% prior to 2020 to 11.6% after 2020.

Joinpoints identified in 2021: Hormozgan, Kohgiluyeh and Boyer-Ahmad, Kurdistan, North Khorasan, and Khorasan Razavi provinces exhibited an upward trend in MBR prior to 2021. Following 2021, all these provinces, except Kohgiluyeh and Boyer-Ahmad, demonstrated a sharp increase in MBR. The results of the MBR analysis by provinces are presented in table 1.

Discussion

This study investigated the trend of multiple births in Iran over the past decade. The findings indicated that MBR in Iran increased at an average annual rate of 2.38% between 2014 and 2023. Additionally, the results revealed that nearly all provinces across the country experienced an increase in MBR in recent years.

Table 1. Trends of MBR across different provinces of the country

Provinces	Before joinpoint-year		Joinpoint-year	After joinpoint-year		Model proportion trend
	APC of MBR (95%CI)	p-value		APC of MBR (95%CI)	p-value	
West Azerbaijan	-2.35 (-7.93, 1.8)	0.23	2017	3.88 (2.22,9.21)	0.01	
Lorestan	-3.29 (-9.21, 0.92)	0.14	2017	5.27 (3.76, 8.96)	<0.001	
Tehran	-0.83 (-2.79, 0.41)	0.19	2018	5.12 (4.09, 6.52)	<0.001	
Mazandaran	-1.59 (-8.55, 1.91)	0.24	2018	4.35 (1.66, 11.57)	0.02	
Yazd	-2.04 (-11.21, 7.36)	0.28	2018	4.09 (-5.12, 14.55)	0.1	
Bushehr	-4.2 (-13.19, -0.87)	0.01	2019	7.92 (2.97, 20.03)	<0.001	
Chaharmahal and Bakhtiari	-1.54 (-9.3, 1.94)	0.23	2019	5.09 (0.63, 14.41)	0.03	
East Azerbaijan	0.74 (-1.66, 2.22)	0.5	2019	7.75 (5.45, 11.96)	<0.001	
Hamadan	-0.39 (-9.71, 9.67)	0.58	2019	5.97 (-4.06, 18.21)	0.09	
Isfahan	-0.91 (-2.31, 0.04)	0.06	2019	6.64 (5.06, 9.12)	<0.001	
Kermanshah	-0.15 (-6.09, 2.16)	0.77	2019	8.82 (5.42, 16.97)	<0.001	
Sistan and Baluchestan	-1.84 (-3.37, -0.94)	<0.001	2019	4.37 (3, 6.58)	<0.001	
Alborz	-1.09 (-5.09, 0.64)	0.16	2020	11.24 (4.77, 21.55)	<0.001	
Ardabil	0.17 (-2.98, 1.72)	0.97	2020	11.6 (6.02, 21.19)	<0.001	
Fars	0.69 (-1.04, 1.7)	0.32	2020	9.69 (6.32, 15.44)	<0.001	
Gilan	-1.86 (-11.05, 1.65)	0.16	2020	7.9 (0.24, 19.06)	0.04	
Golestan	0.96 (-4.66, 2.81)	0.62	2020	8.68 (3.59, 16.19)	<0.001	
Kerman	0.002 (-2.26, 1.02)	0.84	2020	7.65 (3.8, 13.5)	<0.001	
Khuzestan	0.26 (-2.8, 1.22)	0.89	2020	5.06 (2.16, 9.89)	<0.001	
Markazi	-2.45 (-9.01, -0.11)	0.04	2020	13.03 (4.12, 27.2)	<0.001	
Qazvin	0.51 (-5.3, 3.24)	0.95	2020	6.46 (1.61, 13.98)	0.01	
South Khorasan	-1.61 (-6.34, 2.32)	0.07	2020	2.61 (-1.17, 8.19)	0.22	
Hormozgan	1.79 (-4.71, 9.98)	0.52	2021	9.5 (0.57, 15.87)	0.04	
Kohgiluyeh and Boyer-Ahmad	0.99 (-9.78, 16.65)	0.96	2021	11.54 (-4.47, 21.68)	0.12	
Kurdistan	1.31 (-0.21, 2.26)	0.08	2021	12.21 (6.78, 16.04)	<0.001	
North Khorasan	0.74 (-4.76, 4.53)	0.94	2021	10.72 (1.27, 17.45)	0.005	
Khorasan Razavi	0.66 (-0.78, 1.16)	0.2	2021	6.45 (2.31, 8.49)	<0.001	
Semnan	2.49 (0.4, 4.46)	0.02	-	-	-	
Qom	1.75 (0.79, 2.67)	<0.001	-	-	-	
Ilam	2.66 (-0.95, 6.38)	0.15	-	-	-	
Zanjan	2.55 (0.83, 4.29)	0.002	-	-	-	
Iran	**0.24 (-0.59, 0.84)**	**0.46**	**2020**	**6.8 (4.96, 10.13)**	**<0.001**	

Consistent with the findings of the present study, it was observed that the global incidence of twin births has increased by approximately one-third, rising from 9 *per* 1,000 to 12 *per* 1,000 live births.

Triplet, quadruplet, and multiple births have also increased at a faster rate (12, 13). Multiple birth rates have also risen in developed countries over the past four decades, with nations such as England, Wales, France, and the United States experiencing an increase of 50 to 60% in twin birth rates (14-16). A study conducted in China demonstrated that the average rate of multiple births increased annually by 0.81%, rising from 11.9% in 2015 to 15.1% in 2019 (17).

Indeed, multiple pregnancy results from complex interactions between genetic and environmental factors. In addition to hereditary factors, advanced maternal age, the use of ARTs, and high parity are also recognized as contributing factors (18, 19). For instance, alongside the rise in the average number of multiple births in China, the average maternal age at childbirth has also increased by nearly four years over the past eleven years (17). Similarly, evidence indicates that the mean age of women experiencing multiple births is approximately two years higher than that of women with singleton births (17). In fact, advanced maternal age is linked to the social trend of delayed childbearing and contributes substantially to the incidence of multiple births (9). Conversely, advancing maternal age and infertility contribute to an increased rate of spontaneous multiple pregnancies as well as greater utilization of ARTs (9, 20-22).

Infertility is a significant public health concern, with an estimated lifetime prevalence of 17.5% globally and 10.5% in Iran (95%CI: 7.8–13.2 for Iran; 15.0–20.3 globally) (23). As a result, pregnancy rates using ARTs have increased in recent years (6, 10, 17, 24). The rising prevalence of infertility has resulted in the unprecedented use of treatments such as ovarian stimulation, which promotes the development of multiple follicles (13). These significant medical advancements have contributed to an increasing trend in multiple births (6). The extent of prenatal care utilization exerts a significant influence on the incidence of multiple births, with greater access to and utilization of prenatal care being associated with an increased likelihood of multiple pregnancies. Conversely, insufficient prenatal care often leads to pregnancy complications, such as low birth weight, asphyxia, and reduced neonatal length and head circumference, which are correlated with a lower incidence of multiple births. Thus, enhanced prenatal care is linked to an increase in multiple births, whereas inadequate care contributes to adverse outcomes and a reduction in their occurrence. This phenomenon can be attributed to timely prenatal examinations, which furnish healthcare professionals with more precise information regarding fetal development, enable the adjustment of medical interventions during pregnancy, and ultimately provide pregnant women with evidence-based guidance, thereby improving their nutritional intake (25-27).

Meanwhile, the influence of a country's legal and policy frameworks on the incidence and management of multiple births should not be overlooked. As a result of the recent changes in China's population policy, the proportion of multiple births among newborns has increased (6). Furthermore, following the implementation of the two-child policy in 2015, the utilization of ARTs has risen rapidly, contributing to an increase in the incidence of multiple births. In 2022, China amended the Population and Family Planning Law to reinforce regulations regarding the legal age of marriage, promote eugenic principles, and support the implementation of the three-child policy. The adoption of ARTs may further expand subsequent to the enactment of legislation aimed at lifting birth restrictions (17). In Iran, "Family Protection and Youthful Population Law" was enacted in 2021 with the objective of increasing the fertility rate and addressing the challenges posed by an aging population. This law, while limiting access to contraceptive and abortion services, offers incentives to families with higher numbers of children (11). These policies have facilitated access to infertility treatments while restricting contraceptive methods, aiming to promote higher fertility rates (12). These changes may indirectly contribute to a greater utilization of ARTs, thereby leading to an increase in multiple pregnancies.

It is important to note that the current study did not account for variables such as maternal age, type of infertility treatment, obstetric history, or socioeconomic factors, which may influence the interpretation of the findings.

Conclusion

The findings of this study indicate that the incidence of multiple births in Iran is rising, consistent with global trends. This increase appears to be influenced by several factors, including advancing maternal age, the growing prevalence of infertility, expanded utilization of ARTs, and recent changes in population policies. This study

only examined the trend, and further studies are needed to investigate the variables affecting the increase in multiple births. It is recommended that future research employ study designs that specifically examine factors such as educational attainment, household income, treatment modalities, and the aforementioned variables in relation to maternal outcomes. Moreover, in light of the rising incidence of multiple births, it is imperative for policymakers to prioritize support programs encompassing prenatal care and financial assistance.

Considering the medical, social, and economic implications of multiple births, a comprehensive analysis of this trend, along with strategic planning for prenatal care, family support, and evidence-based policymaking, is warranted.

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Conflict of Interest

The authors declare that they have no real or perceived conflicts of interest.

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