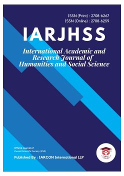

Article

Analysis of Population and Demographic Changes in the Period (2015-2020) using Statistical Tools: A Case Study of Iraq

Basher Faisal Mohammed[1]

[1] National Center for Population and Demographic Studies, 10071, University of Baghdad , Iraq
* Correspondence: basher.f@ncpds.uobaghdad.edu.iq .

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Abstract: This research aims to analyze population and demographic changes in Iraq during the period from 2015 to 2020, based on available data analyzed in the practical aspect. This period constitutes a sensitive and crucial time frame due to the social and political transformations witnessed in Iraq. The analysis revolves around factors influencing population growth and demographic changes in Iraq during this period. The data reveals a significant increase in the population, with rising birth rates and declining death rates. This demographic shift reflects improvements in healthcare and living conditions, indicating the impact of social transformations and developments in marriage and family rates. Urbanization plays a substantial role in Iraq's population, influencing the geographical distribution of resources and infrastructure. Spatial analysis shows an increasing trend of population moving towards urban areas, opening doors to new challenges and opportunities in urban planning and the provision of essential services. The data also carries important insights for the future, as it can be used to predict future demographic changes and their impact on development. Based on the results, it is recommended to direct development efforts towards achieving a balance between population and economic growth, including enhancing infrastructure and improving social services. Overall, this research contributes to clarifying the complex relationship between demographic changes and development in Iraq, providing a conceptual framework that can aid in strategic decision-making and achieving sustainable development in the future.

Keywords: Population, demographic, Statistical Tools, Fertility, Mortality.

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1. Key Points and Background Information:

Iraq, with its long and rich history, undergoes significant demographic and economic transformations that greatly impact its economic development. Analyzing population and demographic changes over a specific period is crucial for understanding the current and future trends of the country, directing policies and strategies towards achieving sustainable development. This research aims to explore the changes that occurred in the population of Iraq from 2015 to 2020 and understand their impact on the country's economic aspects. The analysis focuses on varying birth and death rates, population distribution, and how these changes can influence development direction and future planning.

The data emphasizes the importance of awareness and monitoring of fertility indicators as variables linked to fertility and mortality levels for a comprehensive understanding that informs policy-making alongside demographic conditions [1]. Through studying the case of Iraq, valuable lessons can be extracted on how to deal with challenges arising from population and demographic changes. Analyzing this data will be key to understanding the relationship between population growth and development, constructing development strategies that enhance the quality of life for citizens, and achieve economic and social sustainability.

1.1. Significance of the Research:

The significance of this research lies in understanding population and demographic changes in Iraq from 2015 to 2020. Several aspects highlight the importance of studying the research, particularly in the realm of population planning. Through population planning, a better understanding of demographic changes can be achieved, facilitating the planning of public services. Additionally, examining economic and social policies helps comprehend the relationship between fertility rates, mortality rates, and economic and social growth, contributing to the development of effective policies.

Furthermore, the research holds importance in the context of public health. It provides insights into how changes in mortality and fertility rates contribute to improvements in public health and guide healthcare efforts. Overall, the study is crucial for informed decision-making in population-related planning, public services, economic and social policies, and public health initiatives.

1.2. Research Objectives:

The research aims to analyze and understand population and demographic changes in Iraq, providing valuable contributions to policies and planning in various areas through the following objectives:

1. Demographic Change Analysis: Understand how fertility and mortality rates have changed in Iraq from 2015 to 2020 and analyze these changes.
2. Exploration of Relationships: Analyze the relationships between fertility rates, mortality rates, and potential impacts on these relationships.
3. Prediction of Future Changes: Use the analysis to predict how demographic changes will evolve in the future.
4. Policy Guidance: Provide advice and recommendations to governmental entities and international organizations based on the results to guide policies and ongoing programs in Iraq.

1.3. Research Hypotheses:

The following hypotheses have been formulated to understand the relationships resulting from population and demographic changes:

1. Changes in fertility rates in Iraq may be associated with variations in the population growth rate during the period from 2015 to 2020?.
2. The decline in fertility rates in Iraq during the mentioned period may be linked to changes in mortality rates?.
3. Are fertility rates in Iraq statistically correlated with mortality rates during the years from 2015 to 2020?.
4. The decline in fertility rates can be used as an indicator to understand population changes in Iraq during the specified period?.
5. Have economic changes in Iraq been influenced by the decline in fertility rates, and did they impact demographic changes during the period from 2015 to 2020?.

1.4. Review of Previous Research:

female autonomy, and population behavior and fertility in India. The study utilized demographic data to analyze the impact of social and cultural factors on reproductive behavior.

Caldwell, John C. (1983) [3]: Caldwell presented a comprehensive theory to explain the decline in fertility rates in societies. The study discussed factors influencing the achievement of a decline in fertility rates and demographic transformations.

Bloom, David E., Canning, David, Sevilla, Jaypee (2004) [4]: The researchers studied the relationship between health and economic growth using a production function model. The study illustrated how health and population impact economic capacity.

Mason, Andrew (2003) [5]: Mason studied the experience of East Asia regarding population changes and their impact on economic development. The analysis provided insights into demographic shifts and their effects on economic growth.

Montgomery, Mark R., Stren, Richard, Cohen, Barney, Reed, Holly E. (2003) [6]: They presented a collection of papers and research in their book on the impact of demographic changes on cities and the resulting transformations in high-income areas.

Lee, Ronald, Mason, Andrew (2010) [7]: Explored the relationship between fertility, human capital, and economic growth during the demographic transition. The study highlighted the impact of demographic factors on the economy.

Aghion, Philippe, Howitt , Peter, Bursztyn, Leonardo (2009) [8]: Presented a book to understand the processes of economic growth and the impact of population dynamics and innovation on them.

Firebaugh, Glenn, Goesling, Brian (2004) [9]: Conducted research on global income changes and explanations for reducing economic justice among countries. Researchers.

Karadsheh, M & Hasan, S.I& Al-Mawali ,N.R.(2019) [10]: Mentioned in their study that modernization and development in societies usually lead to changes in the number and composition of populations. For example, economic and social progress may increase the population size and alter age structures and family dynamics. Additionally, advancements in health and environmental policies impact population health and demographic outcomes.

1.5. Concept of Demography:

Demography is the study of populations and their characteristics, including quantity, geographical distribution, and qualitative features such as gender, age, religion, education, and marriage. It aims to understand population changes and their causes, serving as a branch of sociology and human geography. Its scope includes the study of size, distribution, density, composition, races, and growth factors like birth, death, and migration rates. It also seeks to comprehend economic and social conditions and geographic distribution. Population studies explore factors such as the number of children in families, mortality rates, migration reasons, and geographical distribution. This knowledge is essential for identifying current and future human needs. Demography forms the foundation for other social sciences, playing a crucial role in understanding rapidly changing global social phenomena and providing fundamental information for researchers in this field [11–14].

1.6. Demographic Transition in Population Societies:

Demographic transition, also known as demographic shift, refers to the historical shift in birth and death rates from high to low levels. It precedes a decline in both death and birth rates, resulting in rapid growth termed "transitional growth," which is higher than growth before and after the transition. The concept of demographic transition originated in the French demographic world [15], but its integrated formulation was developed by the American economist [16]. Notestein divides demographic transition into three distinct stages based on their historical sequence:

1. Traditional System (Pre-Transition): This stage represents the traditional demographic system before the transition, characterized by high birth and death rates.
2. Transition Stage: The transition stage involves a shift from high birth and death rates to lower levels. It marks the period of rapid population growth.
3. Modern System (Post-Transition): The post-transition stage is characterized by low birth and death rates, leading to a stabilized population. The formulation and conceptualization of demographic transition provide a framework for understanding historical changes in population dynamics and have been influential in demographic and economic studies [17,18].

1.7. Fertility:

Fertility is defined as actual reproduction and is expressed by the number of live births. The primary sources for studying fertility are birth statistics, specifically live births, as records of deceased infants are not included in fertility studies. A live birth, according to the World Health Organization's definition, is the birth of a baby, regardless of the duration of pregnancy, exhibiting any signs of life such as breathing, heartbeat, or clear muscle movement in the hands or feet. Fertility is considered a crucial measure in population studies, influenced by various factors, including economic, social, political, and individual factors. Simultaneously, fertility plays a role in the continuity and renewal of societies [11,19]. Several measures gauge fertility, with key indicators including the crude birth rate, general fertility rate, age-specific fertility rate, children per woman ratio, total fertility rate, and the gross reproduction rate (crude).

1.8. Mortality:

Mortality, in the context of demographic changes, is defined as events leading to the loss of an individual's life. Measuring and analyzing deaths as part of demographic changes helps understand demography and the social, health, and economic developments in a given society. This includes concepts such as the death rate and the leading causes of death. High death rates pose multiple negative challenges to economic development. The elevated rates result in significant loss of human resources, representing substantial investments from both the public and private sectors in areas like education and skill development. Particularly noteworthy in this context is the role of Acquired Immunodeficiency Syndrome (AIDS), leading to a pronounced reduction in social and economic fabric, especially in countries significantly affected by the pandemic [20,21].

The consequences of high death rates also have adverse effects on health and human development, with increased likelihood of disease and sometimes leading to weak physical and mental growth. This negatively impacts the economic capabilities of individuals and communities. In the family context, the death of a parent can reduce educational opportunities and limit future prospects for children. The death rate is measured by calculating the ratio of the number of deaths during a specific annual period to the population at the midpoint of this period. This indicator is associated with several factors that play a crucial role, such as the quality of healthcare, the quality and quantity of available food, and the educational levels of the population. These factors play a vital role in reducing child mortality rates, with their effects varying from one society to another [18].

1.9. Population Growth:

Population growth refers to the variation in the size of a population over different periods, either increasing or decreasing. This concept is related to both population inflation and the population crisis, connected to population movement since populations are not in a constant state but characterized by movement influenced by demographic phenomena such as births, deaths, marriages, and migration [8].

The rates of natural population growth depend on changes in birth rates and death rates, which are, in turn, influenced by various factors [7]. Population growth is a topic that must be considered in demographic studies because the population is characterized by a constantly changing nature. Population growth can be defined as the natural increase, represented by the difference between total births and total deaths, considering net migration, which is the difference between incoming and outgoing migration. This rate contributes to estimating the time required for the concerned region to reach a specific population size in the future [22,23].

The "population growth rate" can be defined as a measure that calculates the rate of natural growth, in addition to the net change (increase or decrease) resulting from migration between different regions [24]. Population growth also refers to the sustainable movement resulting from life activities over a specified period, including births as a factor for an increase and deaths as a factor for a decrease. The term "natural increase" refers to this condition, which not only encompasses population growth but also represents their decrease positively. Additionally, the impact of migration enhances this balance, where incoming migration is considered a factor for increase, while outgoing migration represents a factor for decrease [25].

The definition of population growth emphasizes that the natural tendency for people is to increase and reproduce. If this increase is the result of reproduction, it is called "natural increase." However, if it results from migrants coming from other regions, it is considered "artificial increase") [26]

1.10. Practical Aspect :

The analysis will encompass all data obtained for the years 2015-2020 pertaining to population and demographic changes. According to Table 1, the data represents fertility rates, mortality rates, reproduction rates, and life expectancy rates for the years (2015-2020).

Table 1. Represents data concerning fertility rates, mortality rates, reproduction rates, and life expectancy rates for the years (2015-2020)

Year	Total Fertility Rate	Total Reproduction Rate	Net Reproduction Rate	Average Age at Childbearing	Life Expectancy at Birth (Male)	Life Expectancy at Birth (Female)	Life Expectancy at Birth (Total)	Infant Mortality Rate	Under-Five Mortality Rate
2015	4.08	2.01	1.95	29.1	71	74.9	73	31	38
2016	4.02	1.98	1.93	29.1	71.3	75.2	73.2	30.6	37.5
2017	3.96	1.96	1.91	29.1	71.4	75.4	73.4	30.2	37
2018	3.9	1.93	1.88	29	71.7	75.6	73.6	29.8	36.5
2019	3.86	1.91	1.86	28.9	71.9	75.8	73.8	29.4	36
2020	3.82	1.89	1.85	21	72.1	76.1	74.1	29	35.5

We will now find the simple linear regression and the regression coefficients for the data mentioned in Table 1, which represent the years and the total fertility rate. Using statistical tools and the MATLAB programming language, after executing the code, we obtain the following results:

The regression coefficient (slope) and the intercept value have been determined, describing the relationship between each individual year and the total fertility rate. We can now use this information to understand the trend in the changes of the fertility rate over the years and quantify it.

The time coefficient (slope): -0.0863333333333331 The intercept: 175.74 These results illustrate the coefficients for linear regression, where the time coefficient represents the rate of change in fertility rates over the years, and the intercept coefficient indicates the baseline fertility rate at the beginning (in 2015). The results obtained from linear regression analysis provide an interpretation of the relationship between time and fertility rate. We will interpret the results according to the points below:

Time Coefficient (Slope): The value of the time coefficient is (-0.0863), indicating the rate of change in fertility rates over the years. The negative value suggests a decrease in the fertility rate at an annual rate of (-0.0863) units.

Intercept: The intercept value is (175.74), representing the baseline fertility rate at the start in 2015.

Based on the results, it is evident that the fertility rate was high in 2015 (intercept), but it decreased at an annual rate of (-0.0863) units (time coefficient) starting from that year. This means that there is a decline in the fertility rate over the years.

Referring to Table 1, these data provide an overview of changes in fertility and mortality over six years. They are valuable for monitoring demographic trends and understanding their impact on the population. In summary, the results indicate a decrease in fertility rates over the years.

Total Fertility Rate:

The total fertility rate, also known as the synthetic fertility index, serves as a summary of age-specific fertility rates. It represents the average number of children a woman is expected to give birth to over her reproductive lifespan, usually estimated around 35 years. This rate is generally influenced by the average age at marriage for females, the proportion of widowed females in the fertility age range, and the extent of contraceptive use. The calculation of this rate follows a specific method, as outlined by [19,27].

TFR = $\sum\_i = 15\ 49$ ASFR_i $\times 5$ (1)

Where : TFR is the total fertility rate. _(i=15)̂49 ASFR_i is the sum of age-specific fertility rates for ages 15 to 49. The result is then multiplied by 5.

Rate for the Period (2015-2020) Based on the data obtained from Table 1, there is a noticeable decline in the Crude Birth Rate (CBR) over the years, dropping from 4.08 in 2015 to 3.82 in 2020. This indicates a reduction in fertility rates. The trend is visually represented in Figure 1.

1.11. Total Reproduction Rate:

The total reproduction rate is similar to the total fertility rate, with a slight difference; it considers only female births, excluding males. Therefore, it represents the number of female births expected to be born to a woman during her reproductive years, assuming her fertility conditions align with the current fertility circumstances. It is calculated in the same way as the total fertility rate but only for female births.

In cases where data is available only for total births and the gender ratio, the number of female births can be derived using the formula [27]:

TRR = $\sum\_i = 15■9 ASFR\_i$ (2)

TRR represents the Total Reproduction Rate, and _(i=15)4̂9 ASFR_i is the sum of age-specific fertility rates for women in the age range from 15 to 49, focusing on the births of female children.

From the data obtained in Table 1, we observe that the Total Reproduction Rate also decreased from (2.01) in 2015 to (1.89) in 2020, indicating a decline in the birth rate. This is illustrated in Figure 2.

1.12. Net Reproduction Rate:

This rate is similar to the Total Reproduction Rate, except that it takes into account the death of females before reaching the end of the reproductive age. This makes it a better measure of fertility that indicates the community's ability to replace itself. Therefore, when the Net Reproduction Rate is equal to one, it suggests that, on average, females can be replaced by an equal number of other females. It can be calculated as follows [19,27]:

NRR=_(i=15)4̂9 ASFR_i*li. . . . .(3) NRR is the Net Reproduction Rate _(i=15)4̂9 ASFR_i : Represents the sum of age-specific fertility rates for women in the age range from 15 to 49. Represents the probability of surviving from age i to the end of the childbearing years (usually age 49). This incorporates the effects of mortality.

Based on the data obtained from Table 1, we observe a decrease in the Net Reproduction Rate from (1.95) in 2015 to (1.85) in 2020. This indicates an increase in the mortality rate, as depicted in Figure 3.

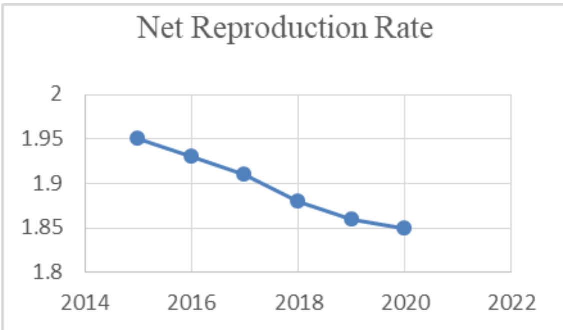

Figure 3. Represents the Net Reproduction Rate for the period (2015-2020).

The average age of childbearing (M): Can be derived using the following formula [19, 27]:

Average Age of Childbearing = Midpoint of Age Group × ∑ of Age-Specific Fertility Rates for a Specific Age Group ∑c

As observed in Table 1, based on the obtained data, there is a significant change from 29.129.1 years in 2015 to 2121 years in 2020. This notable change can impact fertility rates, as illustrated in Figure 4.

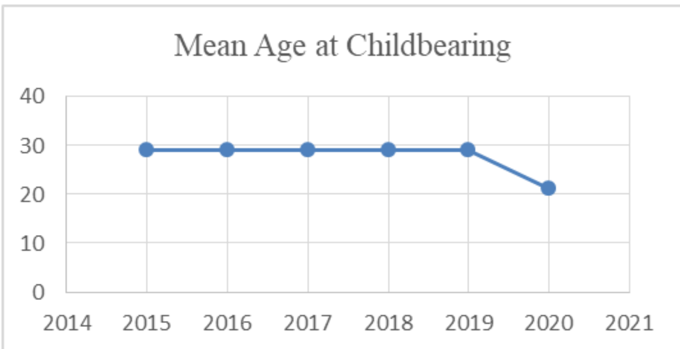

Figure 4. represents the average age of childbearing for the period (2015-2020).

Life expectancy at birth has increased over the years for both males and females, as well as for the total population. This indicates improvement in health and healthcare, as illustrated in Figure 5.

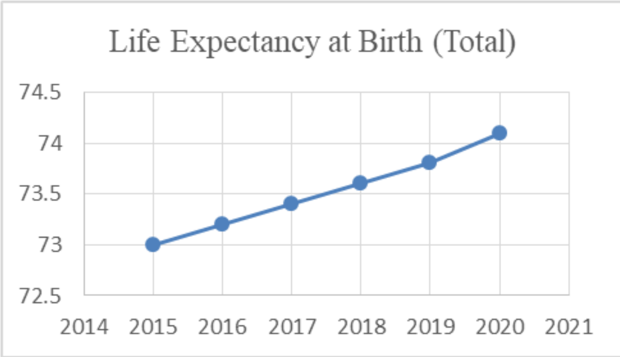

Figure 5. represents the life expectancy at birth (total) for the period (2015-2020).

The infant and under-five mortality rates have generally decreased over the years, indicating an improvement in the health and care of children, as illustrated in Figure 6.

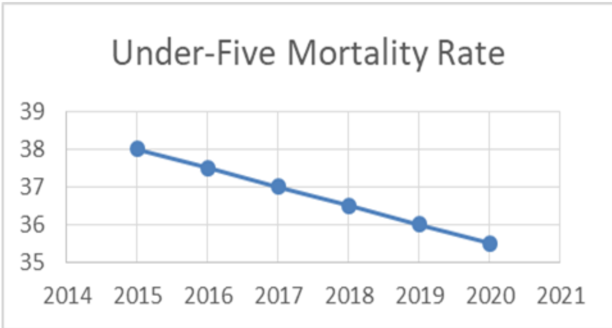

Figure 6. represents the under-five mortality rate for the period (2015-2020).

Through the data below, illustrated in Table 2, which provides us with an overview of demographic trends and changes in population numbers, birth rates, and death rates over the years

Table 2. Demographic Trends and Changes in Population Numbers, Birth Rates, and Death Rates over the Years

Time to Double the Population (years)	Growth Rate (%)	Natural Increase Rate (%)	Crude Death Rate (pier 1,000 population)	Crude Birth Rate (pier 1,000 population)	year
26.2	2.68	2.68	4	30.8	2015
26.6	2.64	2.64	4	30.4	2016
26.9	2.61	2.61	3.9	30.1	2017
27.2	2.58	2.58	5.3	30.2	2018
27.4	2.57	2.57	5.4	30.1	2019
27.6	2.55	2.55	5.4	30	2020

Crude Birth Rate (pier 1,000 population): Births are a crucial element in demographic studies as they significantly impact various population characteristics such as population structure, movement, resource utilization, age distribution, and education. For developing developmental plans, setting policies, and understanding population dynamics, it is essential to analyze birth rates. The rate is expressed in per thousand (‰), representing the number of live births during a specific period per 1,000 mid-year population, calculated using the following formula:

Crude Birth Rate = (Number of live births in a given period / Total population at mid-year) * 1000.

The crude birth rate indicates the number of births in a year per one thousand population. In this case, the average crude birth rate ranged between (30 - 30.8) from 2015 to 2020.

The crude death rate per thousand (per thousand population):

Is considered one of the most widely used measures due to its ease of calculation. It requires only knowledge of the number of deaths from public records and tables in a specific year, along with the population count for that year. This measure is generally easy to use and convenient, and it can be calculated using the following formula [19,21].

Crude Death Rate = Number of deaths during the year / Mid-year population * 1000 Table (1) data shows that the crude death rate indicates the number of deaths in the year per thousand people. In this case, the average crude death rate ranged between (3.9 and 5.4) during the period from 2015 to 2020.

Natural Population Growth Rate (%): The natural population growth rate represents the difference between the birth rate and the death rate as a percentage of the total population. In this case, this rate ranged between (2.55% and 2.68%) over the years. This indicates the percentage of natural population growth.

Growth Rate (%):

The growth rate percentage reflects overall demographic changes and includes population growth due to births and migration. In this case, this rate ranged between (2.55% and 2.68%).

Time Needed for Population Doubling (in years):

This indicator reveals the expected time frame for doubling the population based on the current growth rate. In this case, the period ranged between (26.2 and 27.6) years.

To establish the relationship between the data presented in Tables 1 and 2, we will consider the years as one independent variable, and the vital rates as dependent variables. We will now analyze the relationship between the years and one of the indicators, such as the crude birth rate and crude death rate, using linear regression analysis to determine if there is an increase or decrease over time. Regression analysis will be conducted with the years (variable X) as the independent variable and the indicator (variable Y) as the dependent variable.

After executing the code using MATLAB for data analysis in Tables 1 and 2 we obtain the following results specific to the crude birth rate, as illustrated in Table 3 below:

Table 3. Represents the results of the data analysis related to the crude birth

Coefficient	Value	Interpretation
Slope	0.18833	The slope indicates the expected increase in the crude birth rate for each additional year. In this case, we expect an increase of approximately 0.18833 for each additional year.
Standard Deviation	0.157	The standard deviation indicates the extent of data variability around the regression line. In this case, the standard deviation is close to 0.157, suggesting low variability among the values.
R-Squared	0.940	R-squared is a measure of how well the model explains the variance in the data. In this case, the model can explain approximately 94% of the variance in the crude birth rate.
p-Value	0.00177	The p-value indicates the likelihood of finding the relationship between variables (years and crude birth rate) by chance. In this case, the p-value is significantly low (less than 0.05), indicating that the relationship between years and crude birth rate is not random and is statistically significant.

In summary, the results obtained in Table 3 indicate a statistically significant positive relationship between the years and the crude birth rate. Now, this analysis can be used to predict expected increases in the crude birth rate in the future based on time. To calculate the forecast for the increase in the crude birth rate from 2021 to 2030, we can utilize the regression rate calculated from the previous data. Since the linear rate for the years is approximately 0.18833 (slope of the regression), we can use this information for forecasting.

We can now use this rate to predict the crude birth rate in the future years (2021-2030), as shown in the following Table 4:

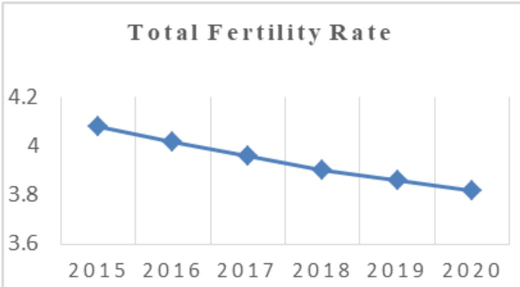

Figure 1. Total Fertility

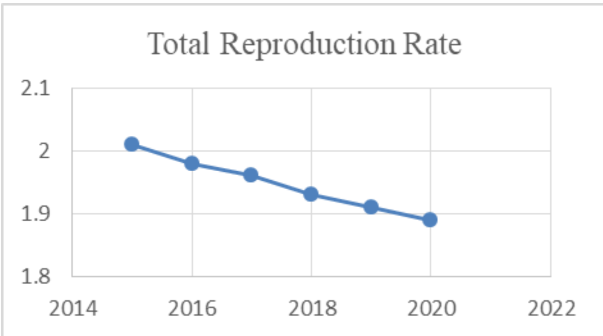

Figure 2. represents the Total Reproduction Rate for the period (2015-2020).

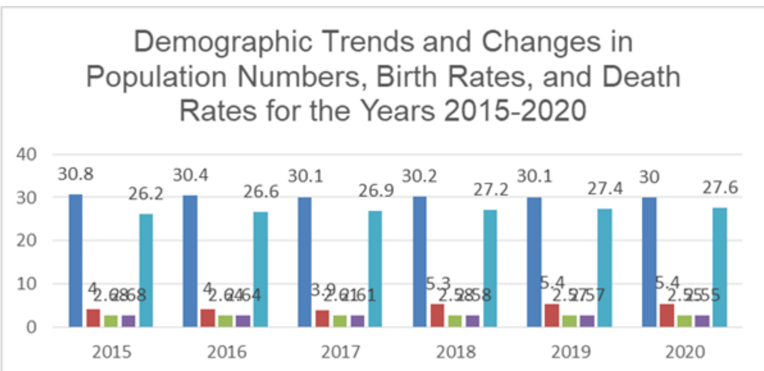

Figure 7. represents the Growth Rate (%) for demographic trends and changes in population size, birth rate, and death rate for the years (2015-2020).

Table 4. Represents the forecast for the crude birth rate for the period (2021-2030)

Year	Forecasted Crude Birth Rate
2021	30.18833
2022	30.37666
2023	30.56499
2024	30.75332
2025	30.94165
2026	31.12998
2027	31.31831
2028	31.50664
2029	31.69497
2030	31.88330

After executing the code using MATLAB and performing data analysis, we obtain the following results specific to the crude death rate, as illustrated in Table 5 below:

Table 5. Represents the results of the analysis for the crude death rate indicators:

Value	Analysis Results
-0.34857	Time Coefficient (slope) for Crude Death Rate
708.37143	Compensation (Intercept) for Crude Death Rate
0.8521	R-Squared Value

These results indicate an inverse relationship between the years and the crude death rate. With a negative time coefficient (slope) of -0.34857, we can observe a decrease in the crude death rate at a rate of 0.34857 for each year. The positive value of the compensation (intercept) suggests the initial value of the crude death rate at the year 2015. The R-Squared value, approaching 0.85, indicates that this linear model explains a significant portion of the variance in the crude death rate over time. To calculate the relationship between the crude death rate and the years, we can use the same approach previously employed for calculating the relationship with the crude birth rate. We will now execute linear regression analysis using years as the independent variable (X) and the crude death rate as the dependent variable (Y).

After executing the code using MATLAB for linear regression analysis with crude death rate data and years, the following results are obtained: The time coefficient (slope) for the crude death rate is approximately 0.05. This suggests a slight increase in the crude death rate by about 0.05 deaths per thousand population each year. The intercept for the crude death rate is approximately 1.6333. This indicates that the crude death rate initially (in 2015) was around 1.6333 deaths per thousand population. These results suggest a slight increase in the crude death rate over time. This information can be utilized to understand trends in the crude death rate and expected changes over the years, as illustrated in the following Table 6:

Table 6. Represents the forecast for the crude death rate for the period (2021-2030)

year	Forecasted Crude Death Rate
2021	0.05
2022	0.1
2023	0.15
2024	0.2
2025	0.25
2026	0.3
2027	0.35
2028	0.4
2029	0.45
2030	0.5

Analyzing the relationship between the Gross Domestic Product (GDP), fertility rates, and death rates in Iraq for the period from 2015 to 2020, linear regression analysis can be employed. Here are the steps that can be taken to perform this analysis:

1. Data Collection: Gather data on the Gross Domestic Product (GDP) for Iraq for each year from 2015 to 2020. Collect fertility rates for each year from 2015 to 2020. Obtain death rates for each year from 2015 to 2020.
2. Organize the data in a standardized table where the year serves as the independent variable (X), and GDP, fertility rates, and death rates serve as dependent variables (Y).
3. Execute Linear Regression Analysis: Implement linear regression analysis using a statistical program like MATLAB. This analysis can help estimate the relationship between the annual Gross Domestic Product and fertility and death rates, verifying if there is a statistical relationship between them.
4. Conclusion: Analyze the results obtained from regression analysis, considering the coefficients and estimates derived from the regression analysis. Regression analysis will allow you to determine if there is a statistical relationship between the Gross Domestic Product and fertility and death rates, and whether there is a significant impact of one on the other.

These steps aid in analyzing the relationship between these variables and understanding how economic and demographic conditions affect each other. Table 7 illustrates the data that will undergo the analysis.

Table 7. Represents the indicators of Gross Domestic Product (GDP), fertility rates, and death rates for the period (2015-2020)

Year	Gross Domestic Product (GDP)	Fertility Rate	Death Rate
2015	2.6	4.08	30.8
2016	13.8	4.02	30.4
2017	-1.8	3.96	30.1
2018	2.6	3.9	30.2
2019	5.5	3.86	30.1
2020	-12	3.82	30

Now we can find the relationship between the Gross Domestic Product (GDP) and the fertility rate. According to the previously mentioned steps, we obtained the following results: Fertility Rate (Slope): Approximately -0.0725 Intercept: Approximately 4.0542

We can also find the relationship between the Gross Domestic Product (GDP) and the death rate using the same steps, and the results are as follows: Death Rate (Slope): Approximately -0.2473 Intercept: Approximately 30.4033

The obtained coefficients suggest a probabilistic relationship between the Gross Domestic Product (GDP), fertility rate, and death rate. Positive coefficients for fertility and death rates indicate an increase in these rates with an increase in GDP, while negative coefficients suggest the opposite – a decrease in fertility and death rates with an increase in GDP.

To interpret the results of the linear regression analysis for the relationship between GDP and fertility rate and death rate, we explain as follows: Relationship between GDP and Fertility Rate: The negative slope coefficient (-0.0725) indicates a negative relationship between GDP and the fertility rate. In other words, as GDP increases, the fertility rate decreases. This may reflect the effects of economic improvement on delaying marriage and reducing the number of children.

Relationship between GDP and Death Rate: The negative slope coefficient (-0.2473) indicates a negative relationship between GDP and the death rate. As GDP increases, the death rate decreases. This may be associated with improved healthcare and better economic conditions that reduce mortality rates. These results emphasize the importance of economic and social factors in determining fertility and death rates. Improving economic conditions and healthcare may lead to a reduction in mortality rates and a delay in childbirth, positively impacting demographic growth and Gross Domestic Product.

2. Conclusion

1. There is a continuous decline in fertility rates over the studied period, indicating a shift in demographic dynamics and the impact of multiple factors on the population.
2. Total fertility rates indicate a slowdown in the birth rate per woman, suggesting a decrease in population growth rates.
3. There is a slight improvement in life expectancy at birth, reflecting progress in health and medical care.
4. A continuous decrease in infant mortality rates, reflecting improvements in living conditions and healthcare.
5. The implications of changes in fertility rates on the population structure, with the possibility of an increase in the proportion of young populations compared to older populations.

Recommendations:

1. Provide awareness campaigns about family planning and the benefits of family planning to reduce fertility rates.
2. Increase investment in healthcare for pregnant women and children to enhance life expectancy and reduce mortality rates.
3. Provide education and training opportunities for youth to improve employment prospects and enhance economic participation.
4. Establish sustainable systems for monitoring and evaluating demographic changes to effectively guide government policies.
5. Encourage more research on factors influencing population changes to better understand the dynamics.

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References

[1] Adnan, Y. M. "Demographic Transition and Variables." Social Issues in Iraq, International Labor Organization, (2021), pp. 21-29.

[2] Dyson, Tim, and Mick Moore. "On kinship structure, female autonomy, and demographic behavior in India." *Population and development review* (1983): 35-60.https://www.jstor.org/stable/1972894

[3] Caldwell, John Charles. "Theory of fertility decline." (No Title) (1982). https://cir.nii.ac.jp/crid/1130000796658800768

[4] Bloom, David E., David Canning, and Jaypee Sevilla. "The effect of health on economic growth: a production function approach." World development 32.1 (2004): 1-13. https://doi.org/10.1016/j.worlddev.2003.07.002
[5] Mason, Andrew. "Population change and economic development: What have we learned from the East Asia experience?." *Applied Population and Policy* 1.1 (2003): 3-14. http://www2.hawaii.edu/ amason/Research/Mason.APP.pdf
[6] Montgomery, Mark, et al. "Demographic Change and Its Implications in the Developing World." Panel on Urban Population Dynamics. *National Research Council*, (2003). DOI:10.4324/9781315065700
[7] Lee, Ronald, and Andrew Mason. "Fécondité, capital humain et croissance économique au cours de la transition démographique." *European Journal of Population/Revue européenne de Démographie* 26 (2010): 159-182. https://doi.org/10.1007/s10680-009-9186-x
[8] Aghion, Philippe, et al. "Institutions and Non Convergence Traps." *Institutions and Non Convergence Traps*, (2009), pp. 237–263..https://nla.gov.au/nla.cat-vn4588108
[9] Firebaugh, Glenn, and Brian Goesling. "Accounting for the recent decline in global income inequality." American Journal of Sociology 110.2 (2004): 283-312.https://www.journals.uchicago.edu/doi/abs/10.1086/421541
[10] Karadsheh, M., Hasan, S. I., & Al-Mawali, N. R. "The Impact of Special Economic Zones on the Health and Environmental Conditions of the Population: A Field Study on Duqm in the Sultanate of Oman." University of Sharjah (UoS) *Journal of Humanities and Social Sciences*, vol. 16, no. 1, (2019), pp. 317-353.
[11] Huda, Dana. "Lectures on Demography." University of Basra, College of Arts, Department of Geography and Geographic Information Systems, (2021).
[12] Zaki, Hassan. Introduction to Population Science and Its Applications. International Population Council, (2010), pp. 247-248. https://www.slideshare.net/ZakiLukeSwemBeba/zaki-swem-beba-thesis
[13] Al-Saad, Hadi. Lectures in Demography. University of Basra, College of Arts, (2021), pp. 1-2.
[14] Pesando, Luca Maria, et al. "Demography as a Field: Where We Came From and Where We Are Headed." Canadian Studies in Population 50.3 (2023): 4.https://link.springer.com/article/10.1007/s42650-023-00076-8
[15] Girard, Alain. "Adolphe Landry et la démographie." Revue française de sociologie (1982): 111-126.https://www.jstor.org/stable/3320853
[16] Notestein, Frank W. "Population-The long view." Food for the World. (1945): 36-57.Notestein, Frank W. "Population-The long view." Food for the World. (1945): 36-57.
[17] Hweidi, Ahmed. Arab Security in the Face of Israeli Security. Dar Al-Taleea, (1975), Beirut.
[18] Al-Bayati, Fadhel. Population Explosion and Social Challenges. *Ghidha Publishing and Distribution House*, (2011), pp. 89-90.
[19] Qawas, Mohammed. Lectures on Demographic Analysis. University of Mostefa Ben Boulaïd/Batna 2, (2020), pp. 9-15.
[20] McNicoll, Geoffrey. "Population and development: *An introductory view*." (2003). DOI:10.31899/pgy6.1078
[21] Yakhlef, Samir. Lectures in Population Science. Faculty of Humanities and Social Sciences, *Guelma University*, (2020), pp. 71-74.
[22] Cohen, Joel E. "Human population: the next half century." science 302.5648 (2003): 1172-1175. https://doi.org/10.1126/science.1088665
[23] Birdsall, Nancy, Allen C. Kelley, and Steven Sinding, eds. Population matters: demographic change, economic growth, and poverty in the developing world. OUP Oxford, 2001.
[24] Grossman, Gene M., and Alan B. Krueger. "Economic growth and the environment." *The quarterly journal of economics* 110.2 (1995): 353-377. https://doi.org/10.2307/2118443
[25] Mason, Andrew, Ronald Lee, and Sang-Hyop Lee. "The demographic transition and economic growth in the Pacific Rim." The economic consequences of demographic change in East Asia. *University of Chicago Press*, 2010. 19-55.https://www.nber.org/system/files/chapters/c8145/c8145.pdf
[26] Montgomery, Mark R., et al. "Demographic Change and Its Implications in the Developing World." Edited by Panel on Urban Population Dynamics. *National Research Council*, (2003). https://nap.nationalacademies.org/catalog/10693/cities-transformed-demographic-change-and-its-implications-in-the-developing
[27] Moshid, Najat. Summary of Assignments for the Introduction to Demography Course. *University of Algiers* 2, (2020), pp. 1-29.