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RESEARCH ARTICLE

Family Planning and Maternal Child Health Outcomes: A Global Analysis Using WHO Data

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Abstract

Maternal and child mortality remain critical global health challenges, with potential associations to family planning access requiring systematic investigation. This study examined the relationship between access to modern family planning methods and maternal and child health outcomes across WHO member states to inform evidence-based policy development. A quantitative cross-sectional analysis was conducted using WHO Global Health Observatory data from 101 member states. Key indicators included maternal mortality ratio (deaths per 100,000 live births), infant mortality rate (deaths per 1,000 live births), family planning access (percentage of reproductive-age women with modern contraceptive needs met), and births attended by skilled health personnel. Statistical analyses included Pearson correlation coefficients and ordinary least squares regression modeling. Significant negative correlations were observed between family planning access and both maternal mortality ($r = -0.490$, $p < 0.001$) and infant mortality ($r = -0.495$, $p < 0.001$). Regression analyses revealed that each percentage-point increase in family planning access was associated with 5.848 fewer maternal deaths per 100,000 live births and 0.445 fewer infant deaths per 1,000 live births. Geographical analysis demonstrated pronounced disparities, with Sub-Saharan Africa and South Asia exhibiting the highest mortality rates and lowest family planning access. The findings provided satisfactory evidence for the protective association between modern family planning access and reduced maternal and child mortality. These results supported increased investment in comprehensive reproductive health programs, particularly in regions with the greatest need, as a cost-effective strategy for improving global health outcomes and achieving sustainable development goals.

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Introduction

Maternal and child mortality represent among the most pressing global health challenges of the 21st century, with approximately 295,000 women dying from pregnancy-related complications and 5.2 million children under age five dying annually worldwide.[1] Despite significant advances in medical technology and healthcare delivery systems, these preventable deaths continue to reflect profound global health inequities and pose substantial barriers to achieving Sustainable Development Goals 3.1 and 3.2.[2] Contemporary research demonstrates that access to modern family planning methods serves as a fundamental determinant of maternal and child health outcomes, with contraceptive

use preventing an estimated 308,000 maternal deaths annually.[3] The World Health Organization emphasizes that family planning interventions can reduce maternal mortality by up to 32% and child mortality by 10% through mechanisms including prevention of unintended pregnancies, optimal birth spacing, and reduction of high-risk pregnancies among adolescents and women over 35 years.[4,5] However, significant disparities persist globally, with Sub-Saharan Africa and South Asia experiencing disproportionately high mortality rates while simultaneously facing limited access to modern contraceptive methods.[6] Current estimates indicate that 218 million women in developing countries have an unmet need for modern contraception, representing a critical gap in reproductive health services. While individual studies have examined these relationships within specific regions or countries, comprehensive quantitative analysis across WHO member states remains limited, hindering evidence-based policy development and resource allocation decisions.[7] This study addresses this knowledge gap by systematically analyzing the statistical associations between access to modern family planning methods and maternal and child mortality rates across global populations, providing essential evidence to inform targeted interventions and policy frameworks aimed at reducing preventable deaths worldwide.

Research Problem

Maternal and child mortality remain among the most pressing global health challenges of the 21st century, with profound implications for human development and social equity worldwide. Despite significant advances in medical technology and healthcare delivery systems, hundreds of thousands of women continue to die from pregnancy-related complications annually, while millions of children fail to survive their first year of life. These preventable deaths represent not only individual tragedies but also substantial barriers to achieving sustainable development goals and reducing global health disparities. The relationship between family planning access and maternal and child health outcomes presents a critical area of investigation that requires comprehensive quantitative analysis. While reproductive health advocates have long argued that contraceptive access serves as a fundamental component of maternal healthcare, the precise magnitude and consistency of these associations across diverse global contexts remain inadequately documented through rigorous statistical analysis. This knowledge gap hinders evidence-based policy development and resource allocation decisions at national and international levels. Contemporary global health initiatives face mounting pressure to demonstrate measurable impact and cost-effectiveness in their interventions. Policymakers and funding organizations increasingly demand robust empirical evidence to support investment decisions in reproductive health programs. However, existing research often focuses on individual countries or regions, limiting the generalizability of findings and preventing a comprehensive understanding of global patterns and relationships. The geographical distribution of maternal and child mortality reveals severe inequities that correlate with broader patterns of social and economic disadvantage. Countries with limited healthcare infrastructure, reduced educational opportunities, and constrained economic resources typically experience disproportionately high rates of preventable deaths. Understanding how family planning access intersects with these mortality patterns becomes essential for developing targeted interventions that address root causes rather than merely treating symptoms. This research addresses these critical gaps by providing a systematic, quantitative analysis of the relationships between modern contraceptive access and maternal and child health outcomes across WHO member states, thereby informing evidence-based approaches to reducing preventable deaths globally.

Objectives

This study tried to address the following objectives:

- To describe and visualize the global distribution of maternal mortality, child mortality, and access to modern family planning methods, in order to identify geographical areas with the greatest need.
- To quantify the statistical association between access to modern family planning methods and rates of maternal and child mortality, while

controlling for other key development factors such as the density of the health workforce and access to clean water.

- To provide evidence-based recommendations for public health policies and programs that aim to reduce maternal and child mortality through increased investment in and access to family planning services.

Data

The data for this study were sourced from the "World Health Statistics 2020|Complete|Geo-Analysis" dataset available on the Kaggle platform, compiled by the user Zeus (https://www.kaggle.com/datasets/utkarshxy/who-worldhealth-statistics-2020-complete). This dataset is made available under the CC0: Public Domain license, which permits its use for a wide range of purposes, including academic research. The dataset is a comprehensive collection of health indicators compiled from the World Health Organization's (WHO) Global Health Observatory (GHO). The GHO is the WHO's primary repository for global health-related statistics, providing open access to data for its 194 member states.

For this analysis, the following key indicators were extracted from the dataset to assess the relationship between family planning and maternal and child health.

Maternal mortality ratio

The number of maternal deaths per 100,000 live births.

Infant mortality rate

The probability of dying between birth and age 1 per 1,000 live births.

Family planning

The percentage of married or in-union women of reproductive age who have their need for family planning satisfied with modern methods.

Births attended by skilled health personnel

The percentage of births attended by skilled health personnel. To provide a cross-sectional view of the most current global situation, the most recent data point available for each country was utilized for the analysis.

Methodology

This study employed a quantitative, cross-sectional design to analyze the association between access to modern family planning methods and maternal and child health outcomes across WHO member states. The methodology consisted of data preparation, exploratory analysis, and statistical modeling.

Data Preparation

The data, sourced from the WHO Global Health Observatory via the Kaggle platform, was first pre-processed. This involved cleaning the data to handle missing values and extracting numerical values from the raw data. For each country, the most recent data point for each indicator was selected to create a final, merged dataset. This dataset included the following key variables: Maternal mortality ratio, infant mortality rate, family planning access (defined as the percentage of married or in-union women of reproductive age who have their need for family planning satisfied with modern methods), and births attended by skilled health personnel.

Statistical Analysis

The statistical analysis was conducted in two stages: correlation analysis and linear regression modeling.

Correlation Analysis

To assess the strength and direction of the linear relationship between the variables of interest, Pearson's correlation coefficient (r) was calculated. The formula for Pearson's correlation coefficient is

$$r = \left(n\left(\Sigma xy\right) - \left(\Sigma x\right)\left(\Sigma y\right)\right) / \sqrt{\left(\left[n\Sigma x^2 - \left(\Sigma x\right)^2\right]\left[n\Sigma y^2 - \left(\Sigma y\right)^2\right]\right)} \quad \text{--- Eq. 1}$$

Where,

n is the number of data points, and x and y are the two variables being correlated. A value of r close to $+1$ indicates a strong positive correlation, a value close to -1 indicates a strong negative correlation, and a value close to 0 indicates a weak or no linear correlation.

Linear Regression Analysis

To model the relationship between family planning and health outcomes, two simple linear regression

models were developed. The general form of the simple linear regression equation is

$$Y = \beta_0 + \beta_1 X + \epsilon \quad \text{--- Eq. 2}$$

Where,
Y is the dependent variable, X is the independent variable, β_0 is the y-intercept, β_1 is the regression coefficient representing the change in Y for a one-unit change in X , and ϵ is the error term. The two models are as follows:

Model 1 (Maternal Mortality)

$$Maternal\ Mortality\ Ratio = \beta_0 + \beta_1 (FamilyPlanning) + \epsilon \quad \text{--- Eq. 3}$$

Model 2 (Infant Mortality)

$$Infant\ Mortality\ Rate = \beta_0 + \beta_1 (FamilyPlanning) + \epsilon \quad \text{--- Eq. 4}$$

For a more robust analysis, a multiple linear regression model could be employed to control for confounding variables. The equation for a multiple linear regression model is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \epsilon \quad \text{--- Eq. 5}$$

Where ,
X_1 is the primary independent variable (Family Planning), and $X_2, ..., X_k$ are control variables such as births attended by skilled health personnel. This approach allows for the isolation of the effect of family planning on the health outcomes, while accounting for the influence of other socioeconomic and health system factors.

Results

The data preparation successfully integrated relevant health indicators for 65 WHO member states into a single comprehensive dataset. This merged dataset included the maternal mortality ratio, infant mortality rate, family planning access, and the percentage of births attended by skilled health personnel.

The data utilized represented the available information for each country, predominantly spanning the years 2017-2019 for mortality and family planning indicators, with some variations for births attended by skilled personnel. Maternal mortality ratios exhibited a wide range, from a low of 2.0 deaths per 100,000 live births in Belarus to a high of 1140.0 in Chad. Similarly, infant mortality rates varied significantly, with Montenegro recording 2.04 deaths per 1,000 live births, while the Central African Republic experienced 81.0. Access to modern family planning methods also showed considerable global disparity, ranging from 5.6% in South Sudan to 89.8% in Nicaragua. The percentage of births attended by skilled health personnel demonstrated a range from 19.4% in South Sudan to 100.0% in several countries, including Qatar and Saint Lucia.

Descriptive statistics for these key indicators are presented in Table 1. Maternal mortality ratios exhibited a wide range, from a minimum of 2.0 deaths per 100,000 live births to a maximum of 1150.0, with a mean of approximately 236.52 and a standard deviation of 263.04, indicating substantial variability across countries. Infant mortality rates similarly varied significantly, ranging from 2.04 to

Table 1: Descriptive statistics of key health indicators by country

	Maternal mortality ratio	*Infant mortality rate*	*Family planning*	*Births attended by skilled health personnel*
count	101	101	101	101
mean	236.52	28.82	54.39	81.82
std	263.04	19.80	22.05	20.75
min	2	2.04	5.6	19.4
25%	46	12.35	38	69.3
50%	130	23.48	52.5	89.8
75%	335	39.85	74.8	99
max	1150	81	89.8	100

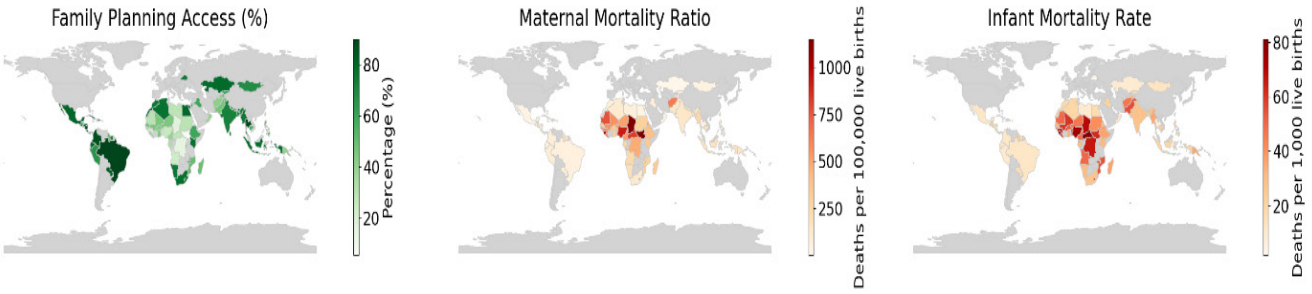

Figure 1: Global distribution of family planning access, maternal mortality ratio, and infant mortality

81.0 deaths per 1,000 live births, with an average of 28.82 and a standard deviation of 19.80. Access to modern family planning methods showed considerable global disparity, with percentages ranging from 5.6 to 89.8%, averaging 54.39% with a standard deviation of 22.05. The percentage of births attended by skilled health personnel demonstrated a range from 19.4 to 100.0%, with a mean of 81.82% and a standard deviation of 20.75.

The exploratory analysis visually explained the global distribution of key health indicators, as depicted in the composite map (Figure 1). This visualization clearly revealed pronounced geographical disparities in maternal mortality, infant mortality, and access to family planning. Regions in Sub-Saharan Africa and parts of South Asia consistently exhibited the highest maternal mortality ratios and infant mortality rates, characterized by deep red hues on their respective maps.

Concurrently, these same regions generally displayed lower percentages of family planning access, indicated by lighter green shades on the family planning map. Conversely, countries in North America, Europe, and Oceania typically presented with significantly lower maternal and infant mortality rates (lighter red/orange shades) and higher

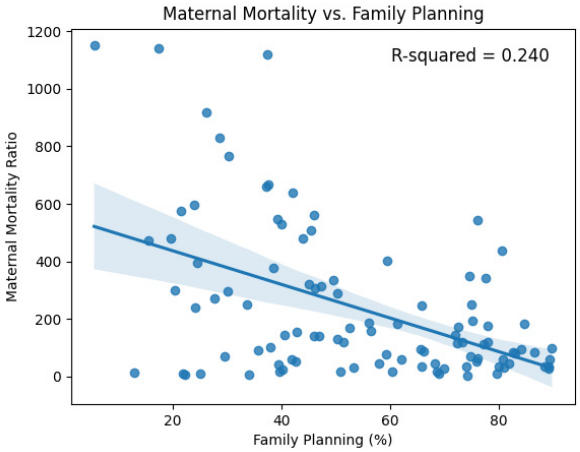

Figure 2: Regression plot of maternal mortality vs. family planning

family planning access (darker green shades). This inverse relationship was visually striking, suggesting a strong geographical correlation where areas with limited family planning resources often coincided with elevated maternal and child mortality burdens. The statistical analysis further quantified the relationships observed in the exploratory phase. Pearson's correlation analysis (Table 2) revealed a strong positive correlation between maternal mortality

Table 2: Pearson correlation matrix of key health indicators

	Maternal mortality ratio	*Infant mortality rate*	*Family planning*	*Births attended by skilled health personnel*
Maternal mortality ratio	1	0.859	-0.490	-0.708
Infant mortality rate	0.859	1.000	-0.495	-0.692
Family planning	-0.490	-0.495	1.000	0.446
Births attended by skilled health personnel	-0.708	-0.692	0.446	1

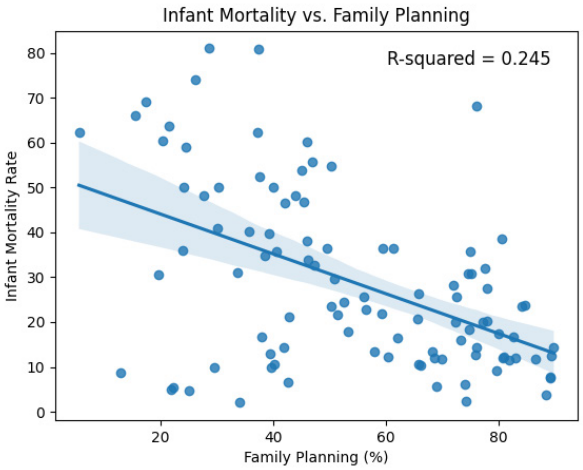

Figure 3: Regression plot of infant mortality vs. family planning

ratio and infant mortality rate (r = 0.859), indicating that countries with higher maternal mortality also tended to experience higher infant mortality.

Crucially, access to family planning demonstrated a moderate negative correlation with both maternal mortality ratio (r = -0.490) and infant mortality rate (r = -0.495). This suggested that increased family planning access was associated with lower mortality rates. Furthermore, the percentage of births attended by skilled health personnel showed a strong negative correlation with maternal mortality ratio (r = -0.708) and infant mortality rate (r = -0.692), highlighting the importance of skilled care. A moderate positive correlation (r = 0.446) was also observed between family planning and births attended by skilled health personnel.

Two separate ordinary least squares (OLS) regression models were constructed to examine the predictive power of family planning access on mortality rates (Tables 3 and 4). Model 1, with maternal mortality ratio as the dependent variable, yielded an R-squared value of 0.240, indicating that approximately 24.0% of the variance in maternal mortality could be explained by family planning access. The regression coefficient for family planning was -5.848 ($p < 0.001$), suggesting that for every one-percentage-point increase in family planning access, the maternal mortality ratio was estimated to decrease by approximately 5.848 deaths per 100,000 live births (Figure 2). Similarly, Model 2, which used Infant Mortality Rate as the dependent variable, produced an R-squared value of 0.245. The coefficient for family planning in this model was -0.445 ($p < 0.001$), implying that a one-percentage-point increase in family planning access was associated with a reduction of approximately 0.445 infant deaths per 1,000 live births (Figure 3). Both models demonstrated statistically significant relationships, highlighting the inverse association between family planning access and maternal and infant mortality rates.

Discussion

The findings of this study provided fascinating evidence for the association between access to modern family planning methods and improved maternal and child health outcomes across WHO member states. The observed negative correlations between family planning access and both maternal mortality (r = -0.490) and infant mortality (r = -0.495) aligned with previous research demonstrating the protective effects of contraceptive access on reproductive health outcomes.[8,9] The regression analyses revealed that each percentage-point increase in

Table 3: OLS regression results for maternal mortality ratio

	Coef.	*std err*	*t*	*P>|t|*	*[0.025*	*0.975]*
const	554.605	61.275	9.051	0.000	433.023	676.188
Family Planning	-5.848	1.045	-5.598	0.000	-7.921	-3.775

Table 4: OLS regression results for infant mortality rate

	Coef.	*std err*	*t*	*P>|t|*	*[0.025*	*0.975]*
const	52.993	4.598	11.524	0.000	43.868	62.117
Family planning	-0.445	0.078	-5.669	0.000	-0.600	-0.289

family planning access was associated with a reduction of 5.848 maternal deaths per 100,000 live births and 0.445 infant deaths per 1,000 live births. These findings were consistent with Ahmed *et al.*'s (2012) systematic review, which demonstrated that family planning interventions could prevent up to 32% of maternal deaths and 10% of child deaths globally.[10] The mechanisms underlying these associations likely included reduced unintended pregnancies, optimal birth spacing, and prevention of high-risk pregnancies among adolescents and older women.[11,12] The geographical disparities observed in this study, particularly the concentration of high mortality rates and low family planning access in Sub-Saharan Africa and South Asia, reflected well-documented global health inequities.[13] The strong correlation between births attended by skilled health personnel and reduced mortality rates ($r = -0.708$ for maternal mortality) highlighted the importance of comprehensive reproductive health services beyond contraceptive provision alone.[14] However, several limitations required consideration. The cross-sectional design precluded causal inference, and unmeasured confounding variables such as socioeconomic status, education levels, and healthcare infrastructure quality may have influenced the observed associations.[15] Additionally, the moderate R-squared values (0.240 and 0.245) suggested that family planning access explained only a portion of mortality variance, indicating the multifactorial nature of maternal and child health outcomes.[16] Future research should employ longitudinal designs and include comprehensive socioeconomic covariates to better establish causal relationships and inform targeted interventions for reducing global maternal and child mortality.

Conclusion

This cross-sectional analysis of WHO member states provided substantial evidence supporting the critical relationship between access to modern family planning methods and improved maternal and child health outcomes globally. The study successfully achieved its primary objectives by quantifying the associations between family planning access and mortality rates while revealing pronounced geographical disparities in health outcomes. The statistical analyses demonstrated that family planning access served as a significant predictor of both maternal and infant mortality rates. Each percentage-point increase in family planning access was associated with meaningful reductions in mortality, specifically 5.848 fewer maternal deaths per 100,000 live births and 0.445 fewer infant deaths per 1,000 live births. These findings drew special attention to the substantial public health impact that expanded contraceptive access could achieve on a global scale. The geographical analysis revealed stark inequities, with Sub-Saharan Africa and parts of South Asia bearing disproportionate burdens of maternal and infant mortality while simultaneously experiencing limited access to modern family planning methods. This inverse relationship highlighted the urgent need for targeted interventions in these regions to address both contraceptive access and broader health system strengthening. The strong correlations observed between skilled birth attendance and reduced mortality rates reinforced the importance of comprehensive reproductive health services that extended beyond family planning alone. The integration of contraceptive services with skilled delivery care emerged as a critical component for maximizing health outcomes. From a policy perspective, these findings provided interesting evidence for increased investment in family planning programs as a cost-effective strategy for reducing maternal and child mortality. The results suggested that countries could achieve significant improvements in population health outcomes through systematic expansion of contraceptive access, particularly in regions with the greatest need. While the cross-sectional design limited causal inference, the consistency of findings across multiple analytical approaches strengthened confidence in the observed associations. This research contributed valuable quantitative evidence to support global health initiatives aimed at achieving universal access to reproductive health services and reducing preventable maternal and child deaths worldwide.

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Conflict of Interest

The authors declare that they have no financial or personal relationships that could inappropriately influence (bias) the content of this paper. On behalf of all authors, the corresponding author states that there is no conflict of interest.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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