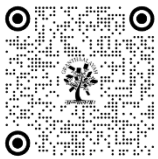


# WOMEN EMPOWERMENT AND ECONOMIC CONTRIBUTION: STATISTICAL ANALYSIS WITH THE CHI-SQUARE TEST

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## ABSTRACT

This study investigates the relationship between women's labor force participation and a country's economic classification using statistical analysis. By employing a Chi-Square Test of Independence on a publicly available dataset of global labor force participation rates, this research evaluates whether income level categories (Low, Lower-Middle, Upper-Middle, High) significantly affect women's engagement in the labor force. The findings suggest a strong association between income group and participation rate category, underscoring the need for policy interventions tailored to economic contexts.

**Keywords:** Women Empowerment, Female Labor Force Participation, Chi-Square Test, Gender Gap, Economic Contribution, Income Groups, HDI Rank, Statistical Analysis, Gender Inequality, Workforce Inclusion

## 1. INTRODUCTION

Women empowerment is both a human rights issue and a critical driver of sustainable economic growth. Across the globe, the role of women in economic systems is increasingly recognized as central to innovation, resilience, and social development. One of the primary indicators of empowerment is women's participation in the labor force, which not only signifies economic inclusion but also reflects deeper societal transformations.

Despite progress in some regions, global disparities persist in women's labor force participation. Cultural, economic, educational, and policy-driven factors often limit women's access to formal employment opportunities. In low- and middle-income countries, women may participate informally or face greater vulnerability in employment conditions. Conversely, high-income nations may offer greater structural access but still face challenges in closing gender gaps.

Empirical studies consistently show that increasing female participation in the labor force correlates with higher GDP, improved family health outcomes, and intergenerational benefits such as education and mobility. Organizations such as the World Bank, UNDP, and McKinsey Global Institute have quantified the economic benefits of gender parity, yet translating these insights into country-specific policy remains complex.

This paper contributes to the growing field of gender economics by exploring the statistical relationship between a country's income classification and the level of female labor force participation. Using a Chi-Square Test of Independence and visual analytics, this study aims to determine whether national income levels are significantly associated with categorized female workforce engagement. By examining gender gaps and regional trends, this research provides actionable insights for policy and development planning.

## 1.1. REQUIREMENT OF THE STUDY

The need for this study stems from persistent gender disparities in economic participation and the uneven progress toward achieving gender equality globally. While global policy frameworks advocate for inclusive growth and gender-responsive development, data-driven insights at the intersection of income classification and labor force participation are limited. This study fills a crucial gap by statistically examining whether a nation's economic standing correlates with women's involvement in its workforce. The research further highlights where policy interventions are most needed to promote equitable access to economic opportunities.

## 2. LITERATURE REVIEW

Numerous studies have explored factors affecting female labor participation, including education, cultural norms, fertility rates, and economic opportunities. The World Bank and International Labour Organization emphasize that economic development and female participation are mutually reinforcing. Countries with high levels of gender equality tend to exhibit better overall economic performance.

For instance, Klasen and Lamanna (2009) found that gender inequality in employment significantly reduces economic growth in developing countries. Similarly, the Global Gender Gap Report by the World Economic Forum (2022) emphasizes that narrowing the labor force gender gap leads to increased national competitiveness and productivity.

McKinsey Global Institute (2015) reported that advancing gender equality in labor markets could add \$12 trillion to global GDP by 2025. Research by Seguino (2000) also links gender equity in employment with long-term development benefits and enhanced national income.

However, limited quantitative analysis has been conducted to directly assess the association between income classification and female workforce participation using categorical statistical tests like the Chi-Square Test. This study seeks to fill this gap by analyzing global labor force participation data through a rigorous statistical lens.

## 3. RESEARCH OBJECTIVES

- To classify countries by income group and female participation rate.
- To statistically test whether income classification is associated with labor force participation levels.
- To visualize the distribution of women's participation levels across economic groups.
- To recommend policy directions based on statistical findings.

## 4. METHODOLOGY

### 4.1. DATASET DESCRIPTION

The dataset used in this study was sourced from Kaggle (<https://www.kaggle.com/datasets/iamsouravbanerjee/labour-force-participation-rate>), and it contains country-wise male and female labor force participation rates from 1990 to 2021. For this study, 2019 values were selected to minimize pandemic-related labor disruptions. Each dataset includes metadata such as HDI rank and continent.

### 4.2. VARIABLES USED

- Independent Variable: Income Group (derived from HDI rank)
- Dependent Variable: Female Labor Force Participation Rate (2019)
- Additional Variable: Male Labor Force Participation Rate (2019)
- Derived Metric: Gender Gap = MaleRate - FemaleRate

### 4.3. CATEGORIZATION

Participation Rate was categorized into:

- High ( $\geq 60\%$ )
- Medium (40%-59.9%)
- Low ( $< 40\%$ )

Income Group was inferred from HDI Rank as:

HDI Rank  $\leq 60$ : High income

- 61–120: Upper middle income
- 121–160: Lower middle income
- 160: Low income

### 4.4. STATISTICAL METHOD

A Chi-Square Test of Independence was applied to a contingency table generated from Income Group vs. Female Participation Category. Additionally, a Gender Gap (MaleRate - FemaleRate) was computed and visualized.

### 4.5. RESEARCH FLOW CHART

- **Data Acquisition:** Collection of global labor force participation data (male and female) from Kaggle.
- **Data Cleaning:** Removing missing values and merging relevant sheets.
- **Variable Selection and Categorization:** Selecting 2019 participation rates and categorizing them into High, Medium, and Low groups. Income group was inferred using HDI rank.
- **Contingency Table Generation:** Creating a cross-tab between income groups and female participation categories.
- **Chi-Square Test of Independence:** Testing whether a significant association exists between income group and female participation.
- **Gender Gap Analysis:** Calculating the male-female participation rate difference.

- **Results Interpretation and Visualization:** Drawing conclusions and plotting relevant charts.
- **Policy Recommendations:** Suggesting economic and social interventions based on findings.

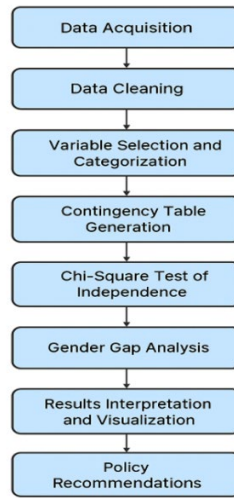


Fig: Flowchart illustrating the research step for analyzing women's labor force participation and gender gap across income groups

A contingency table was created showing the distribution of female participation categories across income groups:

**Contingency Table:**

Income Group	High	Low	Medium
High income	10	6	44
Low income	18	9	8
Lower middle income	14	14	12
Upper middle income	7	24	29

The Chi-Square test yielded the following results:

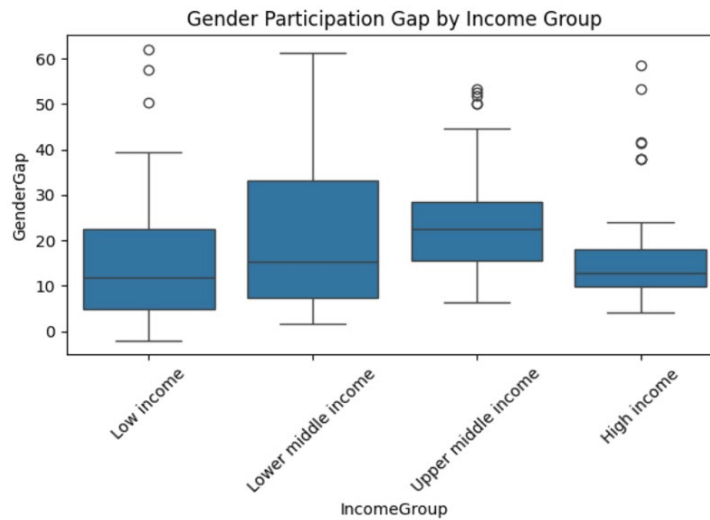
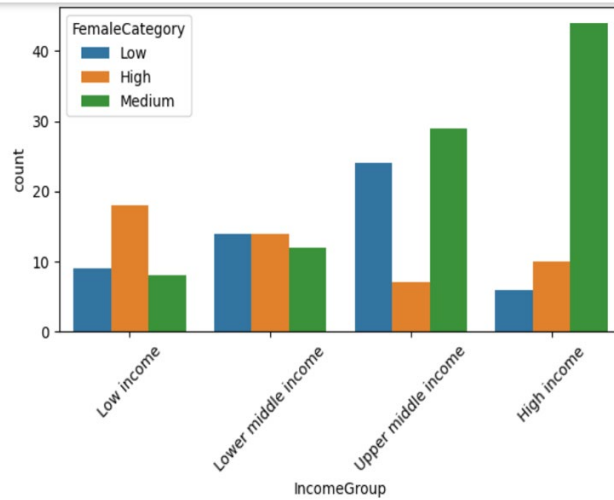
Chi-square value: 43.72

Degrees of freedom: 6

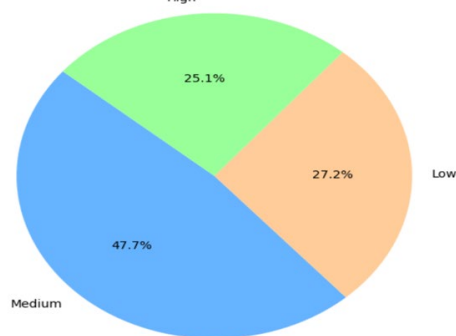
p-value: 0.0000

Since the p-value is less than 0.05, the null hypothesis of independence is rejected, indicating a statistically significant relationship between income group and women's participation rate category.

**Visualizations:**



Distribution of Female Participation Categories (2019)



These visualizations illustrate how high-income countries skew towards 'Medium' participation, while low-income countries show a wider spread, including a substantial 'High' category share.

## 5. DISCUSSION

The test results reveal a statistically significant relationship between income groups and female labor force participation. While high-income countries primarily feature medium participation levels, lower-income groups show more diverse patterns—some with high female participation, possibly driven by necessity-based labor markets.

The Gender Gap analysis further highlights disparities. Even in nations with high female participation, a significant gap exists when compared to male rates. This implies that absolute participation values can mask underlying gender inequalities.

Moreover, socio-cultural dynamics such as patriarchal norms, low access to education, and childcare responsibilities disproportionately affect women's ability to participate in formal employment. These barriers tend to be more prevalent in lower-income regions, where women are often involved in informal or unpaid labor that is not captured in official statistics.

Policy implications include the need for targeted interventions in upper and lower-middle income groups, where female participation is often suppressed due to social, legal, or economic barriers. These may include access to affordable childcare, safe transportation, flexible work policies, vocational training, and gender-sensitive economic policies.

Addressing these issues holistically can help align national labor markets with Sustainable Development Goal 5 (Gender Equality) and SDG 8 (Decent Work and Economic Growth). Collaboration between governments, NGOs, and international development agencies is vital to implement reforms based on empirical data.

## 6. CONCLUSION

The analysis confirms a significant link between income group and women's economic contribution through labor force participation. Additionally, it identifies persistent gender gaps in participation. These findings emphasize the importance of income-sensitive and gender-responsive policymaking. Investment in education, job access, and legal rights for women—particularly in lower and upper-middle income nations—can help balance economic equity and empowerment.

This study underscores the value of using statistical tools like the Chi-Square Test to uncover structural patterns in labor market participation. By categorizing and analyzing participation levels, decision-makers can better target programs and track progress over time.

Future research could integrate additional dimensions such as education levels, urbanization, fertility rates, and gender policies to enrich the analysis. Expanding the time series beyond 2019 or examining post-pandemic shifts in labor force dynamics may also yield actionable insights.

## CONFLICT OF INTERESTS

None.

## ACKNOWLEDGMENTS

None.

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