

A Multivariate Statistical Analysis of UN-FAO Data on Food Security and Nutrition: An Inferential Perspective With Respect To India

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Guide

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Abstract: *This research paper employs multivariate statistical techniques on UN-FAO data to analyze the food security and nutrition status in India. Utilizing principal component analysis, factor analysis, and regression models, it explores the intricate relationships among key indicators. The study reveals changing food security challenges in India, considering global trends and climate change impacts. With a nuanced inferential perspective, it contributes valuable insights for evidence-based policies, aiming to address persistent challenges and promote sustainable food security and improved nutrition in India, potentially offering a model for other regions.*

Keywords: *Food Security, Nutrition, Multivariate Statistical Analysis, UN-FAO, India, Global Trends, Principal Component Analysis, Factor Analysis*

I. Introduction

This research addresses India's critical food security and nutrition concerns amid population growth, global conflicts, and worrisome indices. Urgently aimed at informing policymakers, supply chain managers, and the public, it responds to the evolving energy, infrastructure, and transportation landscape affecting the food supply chain in India. The study's objectives include exploring these issues through data analysis, employing descriptive statistics, and applying advanced statistical techniques to UN-FAO datasets. By delving into the complexities and challenges posed by global trends and climate change, the research strives to provide targeted strategies for improving food security and nutrition.

II. Literature Review

Kumar et al.'s paper (2016)^[1] discusses the issues and challenges of food security in India. They define food security as "a situation that exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

Narayanan's paper (2015)^[2] discusses the importance of food security in India and the challenges that the country faces in

achieving it. These challenges include poverty, inequality, malnutrition, climate change, water scarcity, and an inefficient food distribution system. Narayanan argues that India needs to adopt a comprehensive approach to food security that addresses all of these challenges. She recommends that the government focus on reducing poverty, improving nutrition, investing in climate-resilient agriculture, and improving the food distribution system.

Dev et. al's paper (2010)^[3] discusses government programs that aim to improve food security in India. The authors argue that India still requires plans to increase employment and social security for poor people. They also explore gaps in the government's food security programs.

George et. al's paper (2019)^[4] discusses the Public Distribution System (PDS) in India and its role in food security. The article also details the inefficiencies of the PDS. The PDS is a program that provides subsidized food to the poor. However, it is not working effectively and much of the food is not reaching those who need it. There are a number of reasons for this, including corruption, diversion of food, and a lack of transparency. The government has made some efforts to improve the PDS, such as implementing the National Food

Security Act (NFSA). However, more needs to be done to make the PDS more efficient and effective.

III. Data

A. Data Description

The comparative study examines G20 countries to draw conclusions about India's stand globally. Exclusive focus is given to India in other multivariate statistical analyses. Data spanning from 2000 to 2022 has been gathered from the United Nations Food and Agricultural Organisation (UN-FAO) website, encompassing 25 factors which influence the country's food security and nutrition in various ways.

B. Outlier Analysis

The z-score method was used to analyze outliers. The z-score represents how many standard deviations away the actual value is from the mean. By setting a threshold value for the z-score, we can identify and label data points as anomalies in the overall context.

$$z = \frac{x - \mu}{\sigma} \quad - (i)$$

where, x is the data point, σ and μ are the standard deviation and mean of population, respectively. No outlier was detected for any of the criteria.

C. Handling Missing Values

There were not many missing values present in the dataset. The mean values were used to handle the missing values.

IV. Methodology

A. Exploratory Data Analysis

Exploratory data analysis (EDA) typically occurs early in the analytic process and pertains to initial analyses and conclusions drawn from data sets. Typically, box plots are used to visually depict outliers. Using correlation matrices, correlation coefficients between various variables are represented. A bar graph is used to graphically represent data. It employs bars of varying heights to represent value. A graph with multiple bars depicts two or more interconnected data sets (many bar diagrams facilitate the comparison of numerous phenomena). Line graphs are employed to illustrate trends and patterns in data over time.

B. Descriptive Analysis

The coefficient of variation (C.V.) of each criteria has been calculated and consistency ranking has been done; lower the coefficient of variation, lower is the rank.

$$C.V. = \frac{Mean}{Standard\ Deviation} \times 100 \quad - (ii)$$

Correlation analysis has been done to study the dependency of the criteria on each other.

C. Multivariate Statistical Analysis

Principal Component Analysis has been used to identify the most significant variables contributing to food security and nutrition. It has also been used to assess the correlation structure among different food security and nutrition indicators.

Factor Analysis has been conducted to identify latent factors underlying observed variables related to food security and nutrition and then interpreted in the context of real-world implications and policy implications.

V. Results & Discussions

A. Exploratory Data Analysis

India's Food Security Index in 2022 was found to be 58.9, which was a 1.7 percentage point increase from 2021 (Fig. 1). In 2022, India was in the 68th position among 113 countries (Fig. 2).

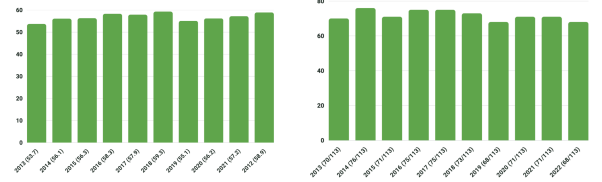


Fig. 1: Overall Score Fig. 2: World Ranking

Though this was an improvement over the 2021 performance, when compared to the G20 countries, India performed the worst (Fig. 3). The overall performance score is a weighted average of 4 indicators - affordability, availability, quality & safety, and sustainability & adaptation (Fig. 4).

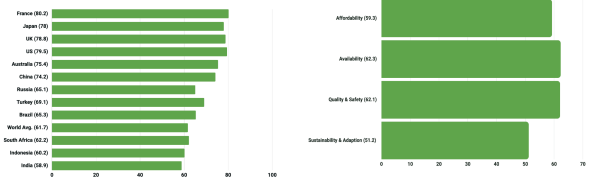


Fig. 3: G20 Countries

Fig. 4: Security Indicators

B. Descriptive Analysis

Criteria "Political Stability & Absence of Violence/Terrorism" was found to have the lowest coefficient of variation while "Percentage of Population using Basic Sanitary Supplies" was found to have the highest coefficient of variation.

Regions with sufficient dietary energy supply tend to have positive correlations with both animal protein and overall protein supply, highlighting adequacy in energy and protein intake. Conversely, a strong negative correlation links dietary energy supply adequacy to undernourishment indicators, suggesting lower undernourishment in areas with ample energy supply.

There exists strong positive correlations between food accessibility and household dietary diversity, as well as utilization. Similarly, availability of food correlates positively with effective utilization and meeting dietary energy requirements. Conversely, food price variability and indicators of malnutrition show strong negative correlations with food accessibility, availability, and effective utilization, suggesting that households facing these challenges are more prone to undernourishment and related issues.

C. Multivariate Statistical Analysis

- Principal Component Analysis:** Principal Component 1 (PC1) was found to be associated with economic development, health, and nutrition, with key criteria such as GDP per capita (PPP), indicators of nutrition and health, infrastructure measures like rail lines density, and political stability. PC2 captured factors related to nutrition, health, and social stability, sharing criteria with PC1. Both components highlighted the interplay between economic and social factors, emphasizing the significance of political stability in influencing these dimensions. PC1 emphasized economic development, while PC2 focused on social stability, nutrition, and food supply patterns, showcasing overlapping influences on economic and social aspects.
- Factor Analysis:** Factor 1 was characterized as an "Economic Development" factor, emphasizing GDP per capita and basic sanitation services. Factor 2 signified "Food Security," with a focus on the variability of caloric consumption and losses in retail distribution. The criterion "Percentage of children under 5 years of age who are stunted" exhibited relevance to both economic development and food security. Factor 3 emerged as a composite factor, incorporating infrastructure, political stability, nutrition, and child health. Lastly, Factor 4 encompassed diverse influences, spanning food supply, economic indicators, caloric consumption, and women's health, indicating a comprehensive spectrum of factors within the dataset.

VI. Conclusion

In conclusion, this research sheds light on the intricate dynamics of food security and nutrition in India, employing rigorous multivariate statistical analyses. The study not only reveals the changing challenges in these domains but also offers valuable insights for evidence-based policymaking. The observed

improvement in India's Food Security Index underscores progress, yet the comparison with G20 nations highlights areas for targeted enhancement. The detailed exploration of factors, as captured by Principal Component Analysis and Factor Analysis, elucidates the interplay between economic, social, and political dimensions. By emphasizing the significance of political stability and unveiling comprehensive factors influencing food security, this research provides a nuanced understanding essential for formulating effective strategies. The findings extend beyond India, offering potential applicability as a model for addressing similar challenges in diverse regions. Overall, this research contributes to the ongoing discourse on sustainable food security and improved nutrition outcomes, offering a foundation for informed decision-making and targeted interventions.

VII. References

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