# Global Child Malnutrition: Patterns, Insights, and Analytical Skills

## (A Multi-Phase Data Analysis of Stunting, Wasting, and Severe Wasting)

## Malnutrition Indicators:

**What it measures?**

**The percentage of children under five who experience:**

- **Stunting:** low height-for-age (chronic undernutrition)
- **Wasting:** low weight-for-height (acute undernutrition)
- **Severe wasting:** very low weight-for-height (severe acute malnutrition)

## Understanding Global Malnutrition:

- **Malnutrition remains a persistent global public health challenge.**
- **Influenced by poverty, food insecurity, conflict, and unequal access to health.**
- **Our analysis examines stunting, wasting, and severe wasting alongside economic and social indicators.**

## Why This Analysis Matters
## Bullets?

- **Objective:** **Demonstrate analytical skills while exploring global malnutrition trends.**

## Data Sources and Analytical Workflow:

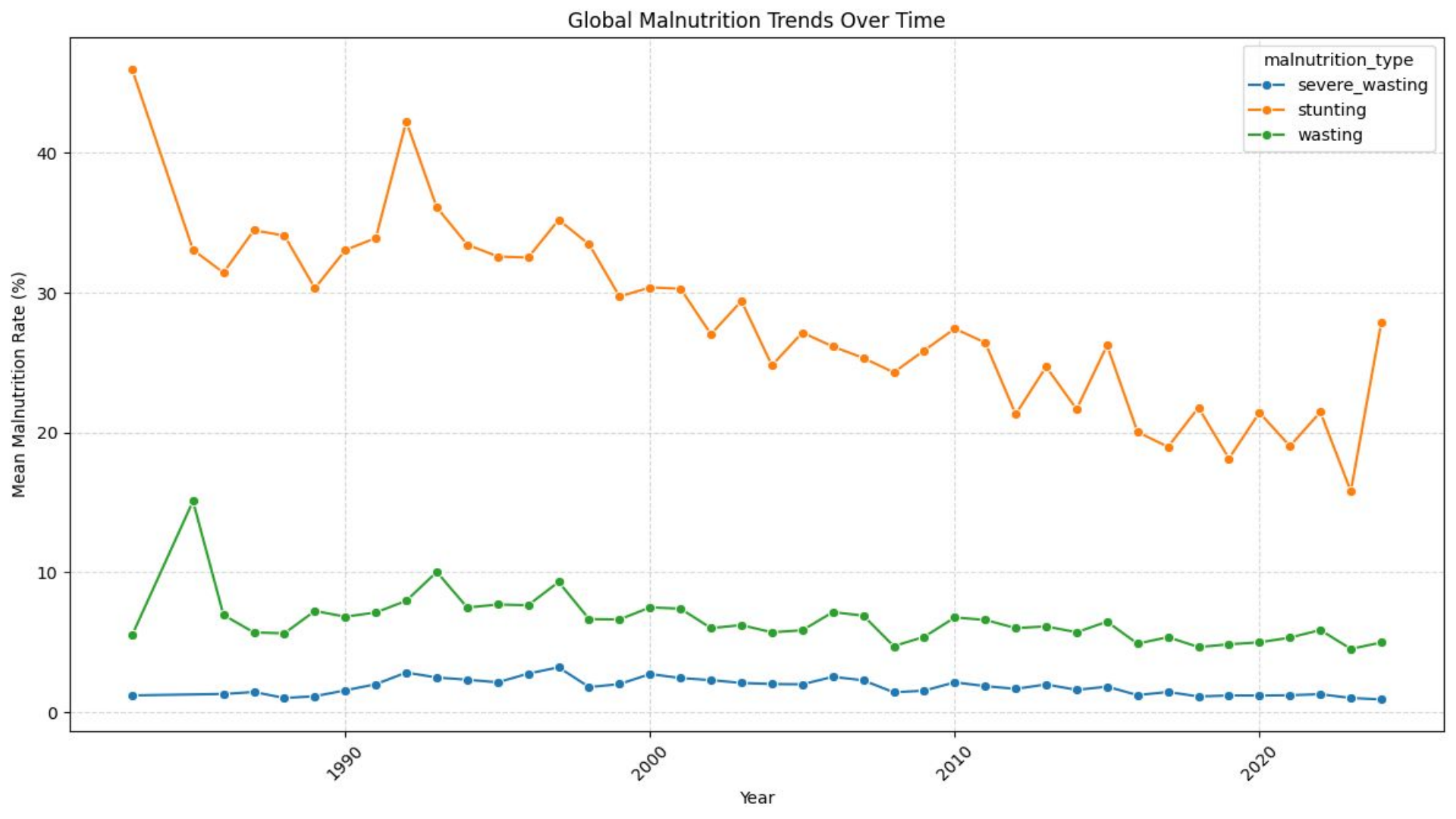
- **Multiple public datasets covering malnutrition, GDP, education, food security, refugees.**
- **Multi-phase workflow:**
  - **Data cleaning & merging**
  - **Exploratory data analysis (EDA)**
  - **PCA & mixed-effects modeling**
  - **Country-specific temporal analysis**
- **Tools: Python (pandas, matplotlib, seaborn, statsmodels)**

## Global Malnutrition Patterns:

- **All three indicators show a clear global decline, pointing to progress in nutrition, health, and socio-economic conditions.**

- **Stunting remains the most prevalent, followed by wasting and then severe wasting.**

- **Stunting declines more smoothly due to long-term development improvements, while wasting and severe wasting respond more to short-term shocks.**


Global Malnutrition Trends Over Time
malnutrition_type
severe_wasting
stunting
wasting
Mean Malnutrition Rate (%)
0
10
20
30
40
1990
2000
2010
2020
Year

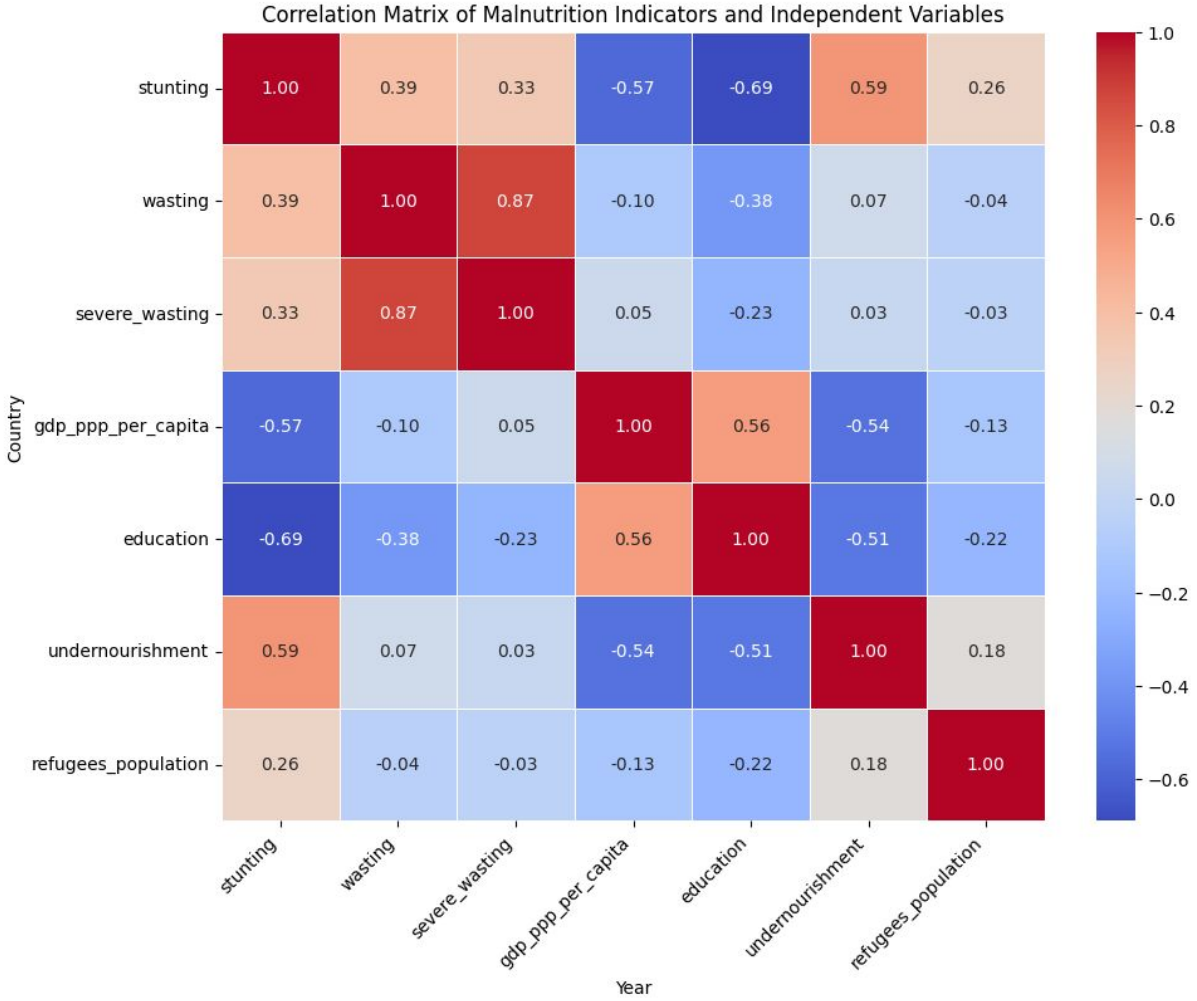
## Cross-Country Differences:

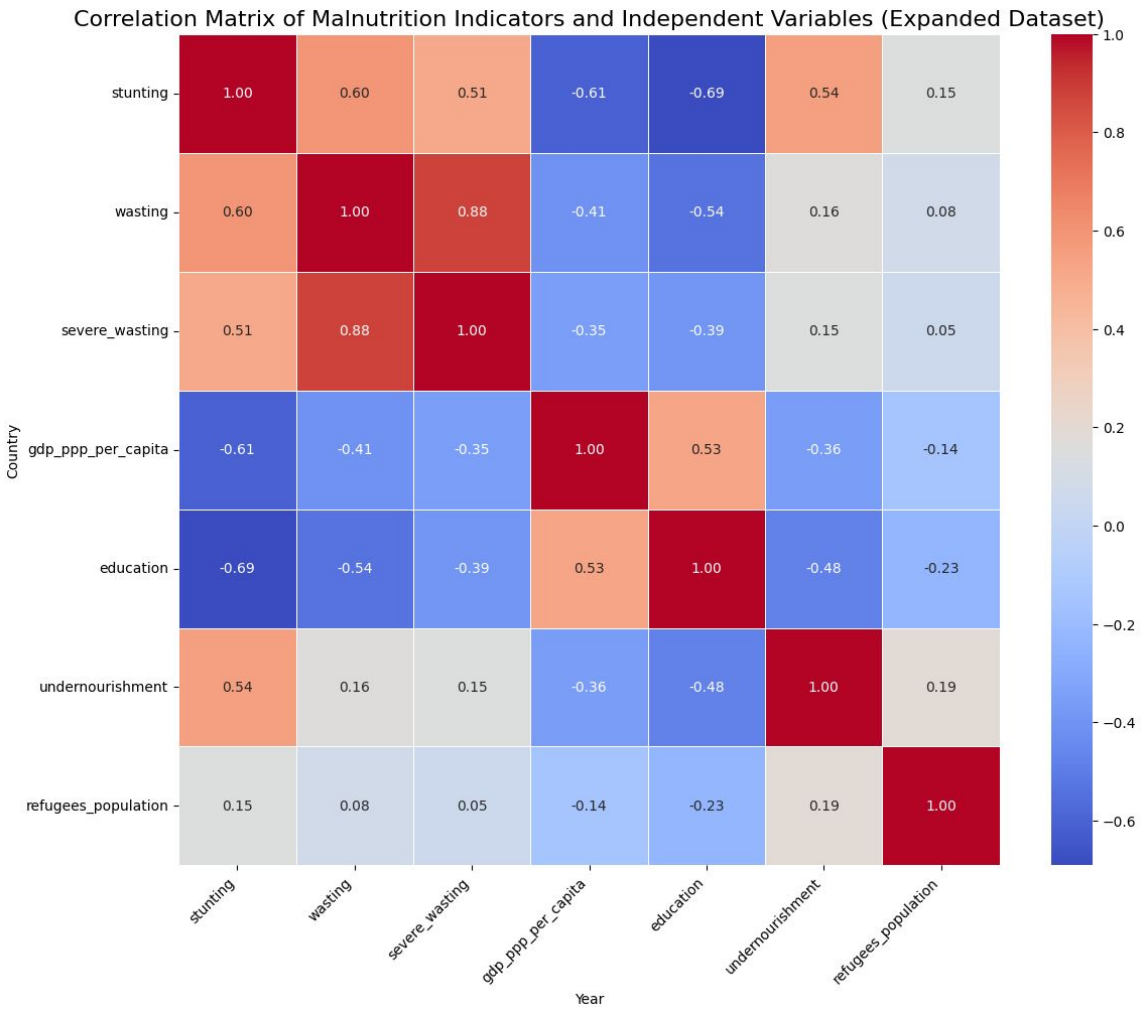
- **Some countries show persistent improvement, others stagnation or reversals.**

- **The strongest patterns appear with stunting, which decreases as GDP and education rise and increases with undernourishment.**

- **Wasting and severe wasting show weaker ties to long term development conditions and may depend more on immediate crises.**

- **Overall, the correlations highlight the importance of economic stability, education, and food availability for reducing chronic malnutrition.**


Correlation Matrix of Malnutrition Indicators and Independent Variables
stunting
wasting
severe_wasting
gdp_ppp_per_capita
education
undernourishment
refugees_population
Country
Year
1.00 0.39 0.33 -0.57 -0.69 0.59 0.26
0.39 1.00 0.87 -0.10 -0.38 0.07 -0.04
0.33 0.87 1.00 0.05 -0.23 0.03 -0.03
-0.57 -0.10 0.05 1.00 0.56 -0.54 -0.13
-0.69 -0.38 -0.23 0.56 1.00 -0.51 -0.22
0.59 0.07 0.03 -0.54 -0.51 1.00 0.18
0.26 -0.04 -0.03 -0.13 -0.22 0.18 1.00
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


Correlation Matrix of Malnutrition Indicators and Independent Variables (Expanded Dataset)
stunting
wasting
severe_wasting
gdp_ppp_per_capita
education
undernourishment
refugees_population
Country
Year
1.00 0.60 0.51 -0.61 -0.69 0.54 0.15
0.60 1.00 0.88 -0.41 -0.54 0.16 0.08
0.51 0.88 1.00 -0.35 -0.39 0.15 0.05
-0.61 -0.41 -0.35 1.00 0.53 -0.36 -0.14
-0.69 -0.54 -0.39 0.53 1.00 -0.48 -0.23
0.54 0.16 0.15 -0.36 -0.48 1.00 0.19
0.15 0.08 0.05 -0.14 -0.23 0.19 1.00
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

## Advanced Modeling Insights:

- **Global Trends:** All malnutrition indicators show a strong declining trend over time.
- **Socio-Economic Development:** Higher PC1 scores (development) predict lower malnutrition, but the effect diminishes over time.
- **Country Differences:** Random intercepts reveal substantial baseline variation between countries.
- **Model Stability:** PCA reduced multicollinearity, improving mixed-effects model reliability.

- **Random Slopes Limitation:** Country-specific time trends could not be robustly estimated due to dataset constraints.

- **Peru Granger Causality:** GDP predicts stunting (3-year lag) and undernourishment predicts severe wasting (2-year lag); other predictors were non-significant.

## Country-level temporal analysis:

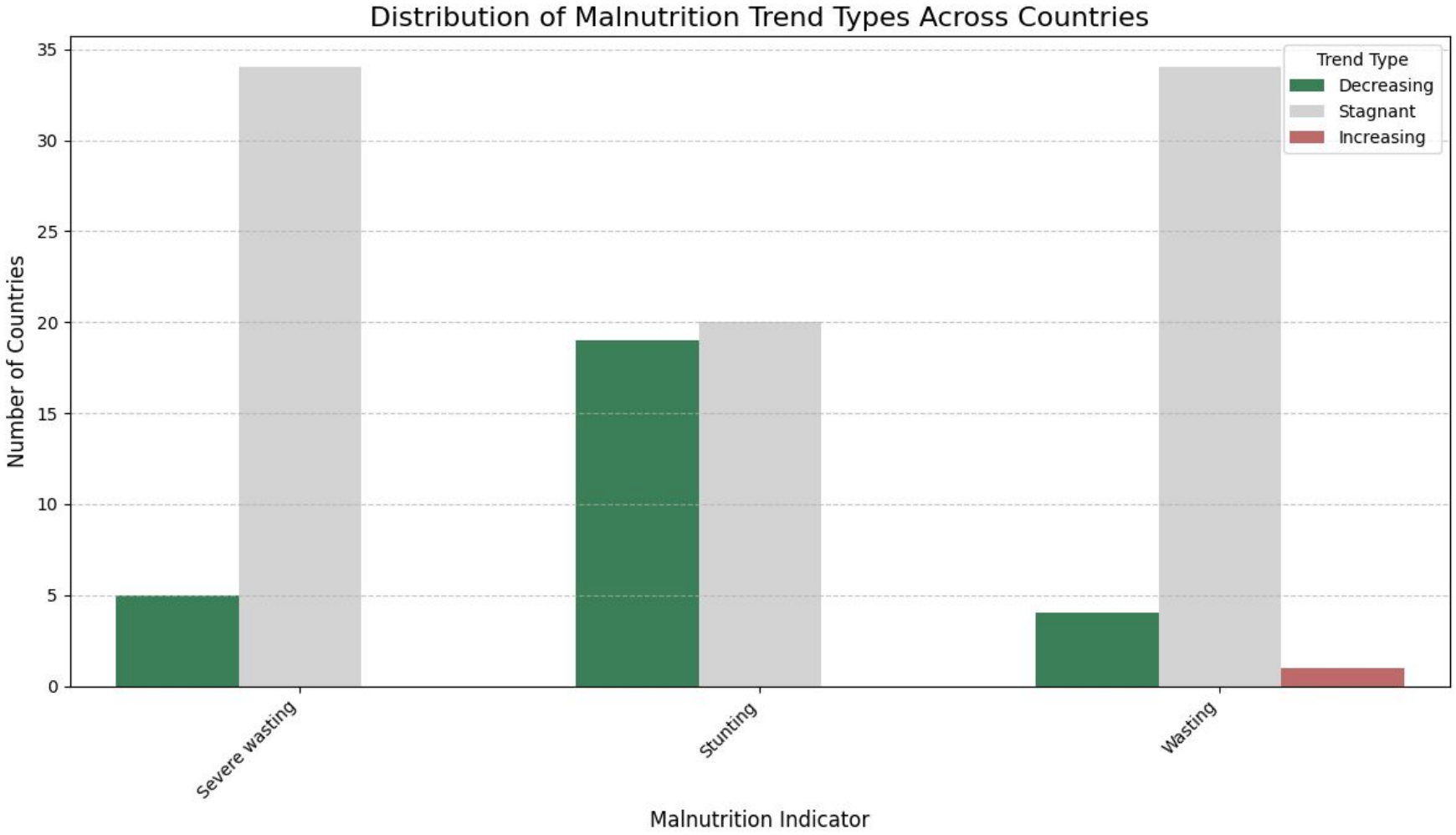
**Phase 4 Summary:** Country-level temporal analysis shows strong long-term declines in stunting, variable trends in wasting, and sharp fluctuations in severe wasting.

**Socio-Economic Indicators:** GDP and education generally improved; undernourishment decreased; refugee populations reflect country-specific events.

**Acute Malnutrition Patterns:** Many wasting trends appear stagnant due to volatility, sparse data, or true plateauing.

**Policy Implication:** Reductions in chronic malnutrition align with development, but acute malnutrition requires targeted, context-specific interventions.

**Data Insight:** Completeness and quality of country-level time series strongly affect trend detection and analysis.

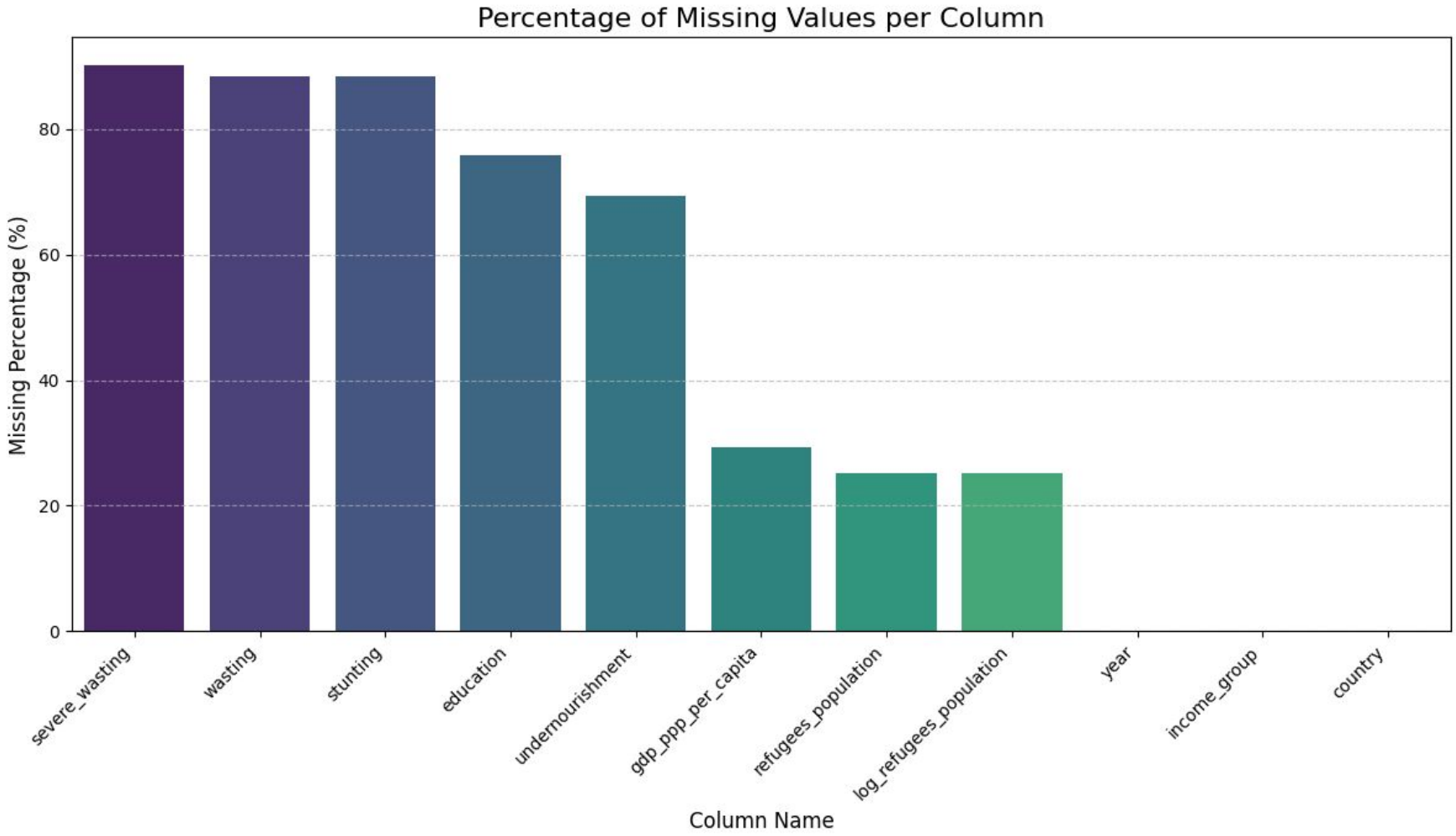

Distribution of Malnutrition Trend Types Across Countries
Trend Type
Decreasing
Stagnant
Increasing
Number of Countries
0
5
10
15
20
25
30
35
Severe wasting
Stunting
Wasting
Malnutrition Indicator

## Practical Insights:

- **Expand maternal education and local health programs.**
- **Strengthen food system resilience and monitoring.**
- **Support conflict-affected and displaced populations.**
- **Focus on analytical rigor and reproducible workflows in reporting.**

## Demonstrating Skills Through Data

- **Analytical workflow illustrates robust handling of complex datasets.**
- **Patterns observed align with known socioeconomic relationships.**
- **Report is a skills-focused artifact for global/public health analytics audiences.**


Percentage of Missing Values per Column
Missing Percentage (%)
0
20
40
60
80
severe_wasting
wasting
stunting
education
undernourishment
gdp_ppp_per_capita
refugees_population
log_refugees_population
year
income_group
country
Column Name