A Comprehensive Analysis of Worldwide Population Dynamic Trends

Kimberly Cardinale (2548934) and Carl Yu (2550364)

Introduction

In this project, we examine the relationships between key indicators of public health and population dynamics across countries using data from the World Bank's World Development Indicators (WDI) database. Our goal is to understand how certain demographic, health, and fertility-related measures are related, and what patterns emerge across different regions or income levels over time.

Data Description

To guide our analysis, we grouped six indicators into three pairs:

1. Adolescent fertility rate (births per 1,000 women ages 15–19) and population growth (annual %) to explore how youth fertility might contribute to overall population change.

   - Adolescent fertility rate serves as an indicator of reproductive health and education access.
   - Population growth reflects demographic shifts and may be influenced by fertility trends.

2. Age dependency ratio (% of working-age population) and life expectancy at birth (years) to understand how population age structure relates to general health and longevity.

   - Age dependency ratio measures the economic burden on the working population.
   - Life expectancy is a common proxy for overall population health.

3. Births attended by skilled health staff (% of total) and infant mortality rate (per 1,000 live births) to assess how healthcare access during childbirth impacts early-life survival.

- Skilled birth attendance indicates healthcare quality and accessibility during delivery.
- Infant mortality rate reflects child health outcomes and overall healthcare effectiveness.

By integrating SQL for data cleaning and transformation and Python for visualization and modeling, we aim to show meaningful patterns and trends within these pairs. Our analysis also considers regional and income-level differences where relevant. Through this approach, we hope to provide insights into how social and healthcare factors contribute to broader population and health outcomes worldwide.

Data Analysis, Results, and Discussion

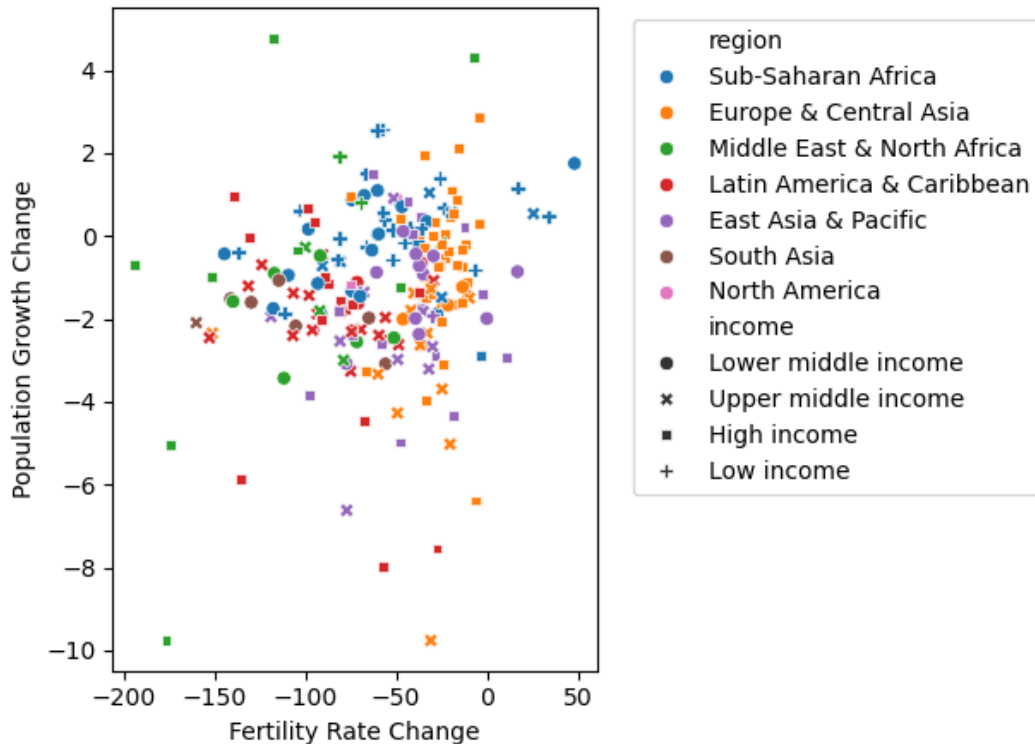### Pair 1: Adolescent Fertility Rate (births per 1000 women ages 15-19) and Population Growth (annual %)

Figure 1: Figure 1

We first plotted the change for all countries across all region and income statuses for adolescent fertility rate and population from 1960-2023, with each point representing a country to provide

a broad visualization and assess any overall trends.

At the global level, both adolescent fertility rate and population growth have been declining from 1960-2023. The regions of Europe & Central Asia as well as East Asia & Pacific, primarily made up of HICs and LMICs, have experienced the smallest declines in adolescent fertility rate from. Otherwise, the rest of the regions and economic statuses emcompass a relatively wide range of changes, albeit negative, in both metrics.
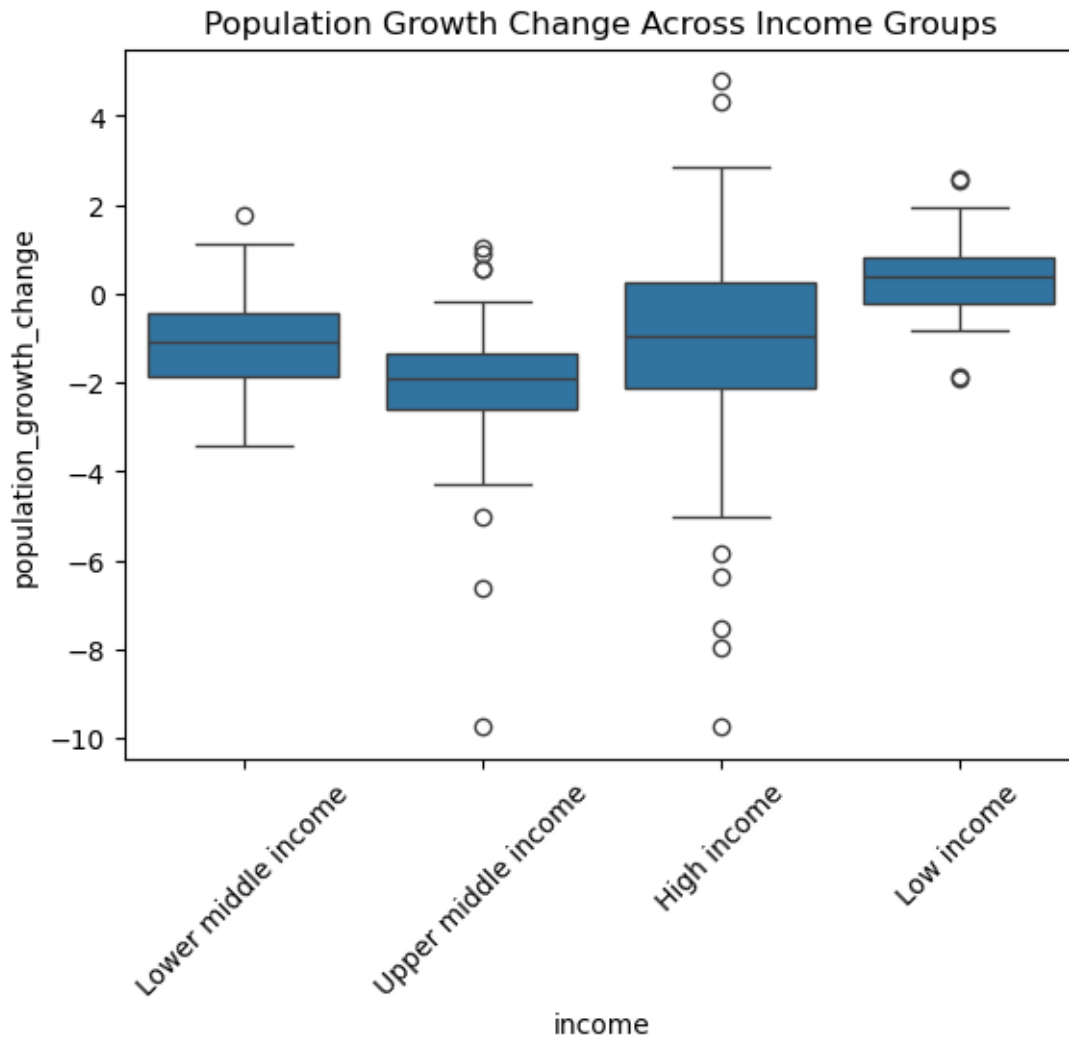

Figure 2: Figure 2

To investigate trends population growth, we plotted a distribution of change in population

growth rates according to countries' income level, independent of region[1].

On average, low income countries have the experienced the highest change population growth rates, and is the only income group that experienced a positive change in population growth rates. High, upper middle, and lower middle income countries all experienced negative changes in population growth rates from 1961-2023, with upper middle income countries on average having the greatest decline in population growth.
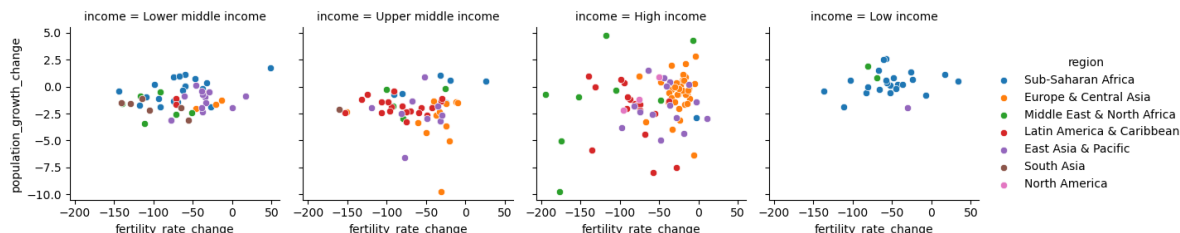

Figure 3: Figure 3

All income groups seem to have a similar spread of change in adolescent fertility rate with most countries experiencing a decline in fertility rate since 1960, though several high income countries from the MENA region seem have experienced exceptionally large drops. Otherwise, the overall trends exhibited low income countries are relatively similar that of lower-middle income countries, though low-middle income countries on average have experienced a slight decrease in their population growth rates as well as adolescent fertility rates.

A systematic analysis for the Global Burden of Disease Study in 2017 on near-global population and fertility patterns discovered that fertility rates for ages 15-19 tend to decrease as countries develop, though countries with similar socio-demographic index scores also exhibited drastically different adolescent fertility rates (Murray et al. 2018). Using income status as an rough indicator of development and assuming that countries have undergone development from the 1960s to 2023, it would be plausible for low income and low-middle income countries to exhibit the most significant decreases in adolescent fertility rate. This trend seems to be largely supported by our data, where high income countries have experienced a smaller decrease on average in terms of adolescent fertility rates relative to both low income and low-middle income countries, which have more significant decreases. At the same time, due to demographic transition, low income countries have experienced the largest increase in ppopulation growth rates. High income countries also have the second highest change in population growth (albeit still negative), which is not necessarily attributed to high adolescent fertility rates. As adolescent births are just a facet of a country's overall population growth, high income countries' increase in population growth rates can likely be attributed to not only births by older adults, but also to other phenomena such as the arrival of migrants countries belonging to different income statuses.

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[1]Data for population growth in 1960 was not available, so change in population growth rate was represented by 2023 annual rate subtracted by the 1961 annual rate.

Pair 2: Age dependency ratio (% of working-age population) and life expectancy at birth, total (years)
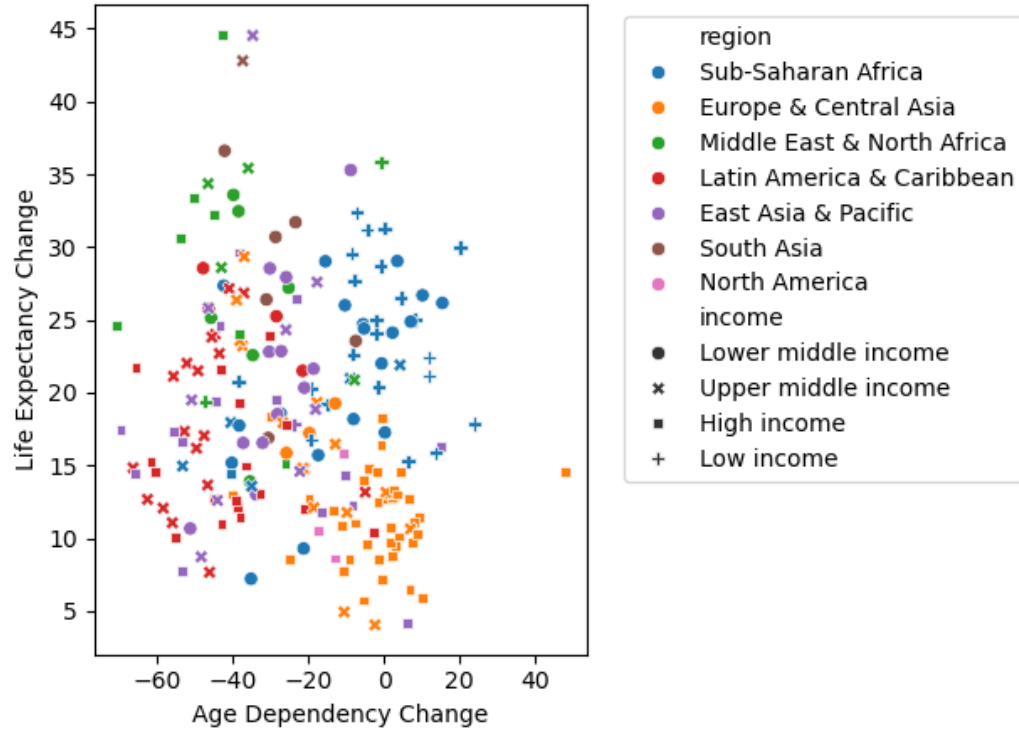

Figure 4: Figure 4

We plotted the change in life expectancy and age dependency ratio for all countries across all regions and income levels together to provide an aggregate visualization.

The countries belonging the regions of Sub-Saharan Africa and Europe & Central Asia share the most similarities with other countries within their own regions. Both these regions have experienced a relatively small change in age dependency, while most other regions seem to have undergone a more significant decrease in age dependency. Globally, all countries experienced an increase in life expectancy, with Europe & Central Asia in particular having experienced the smallest change.
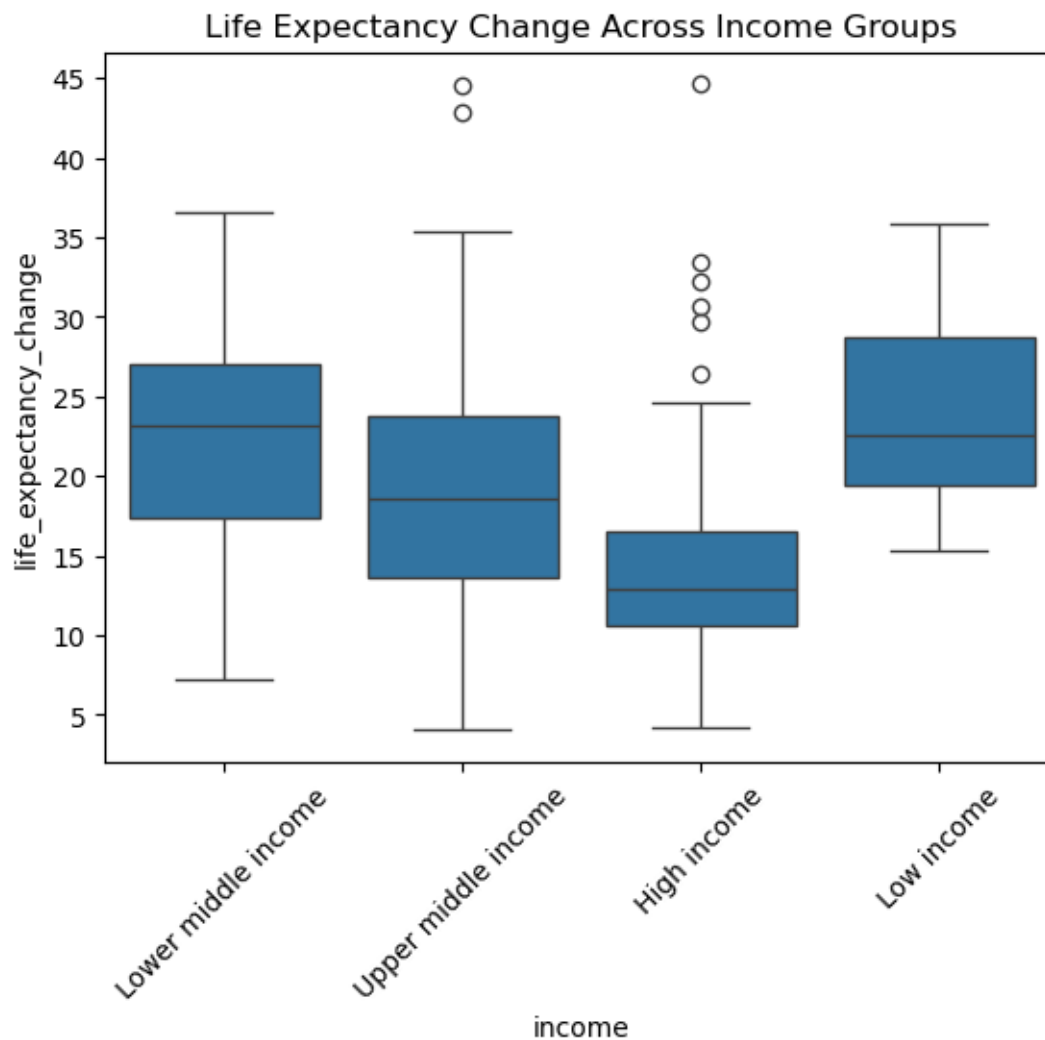
Figure 5: Figure 5

To investigate trends in life expectancy, we plotted changes in life expectancy with respect to different levels of income.

High income countries experienced relatively small increase in life expectancy on average while lower-middle income countries experienced the most significant increase in life expectancy. Low income countries experienced an increase just slightly shy of that of lower-middle income countries and ahve the narrowest distribution of change. However, high income and upper-middle income countries had the widest range in life expectancy changes—they include countries that experienced the greatest increases of 40 years, and some as low as under 5 years.