Data Analysis

```python
# Import Libraries and Read Cleaned Dataset

import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px

df = pd.read_csv('population_dynamics_clean.csv')
```

Life Expectancy Analysis

```python
# Life Expectancy Rate by Country Over Time

plt.figure(figsize=(10, 6))
sns.lineplot(
    data=df,
    x="year",
    y="life_expectancy",
    hue="country",
    marker="o"
)

plt.title("Life Expectancy Over Time by Country", fontsize=14)
plt.xlabel("Year")
plt.ylabel("Life Expectancy (Years)")
plt.legend(title="Country")
plt.tight_layout()
plt.show()
```
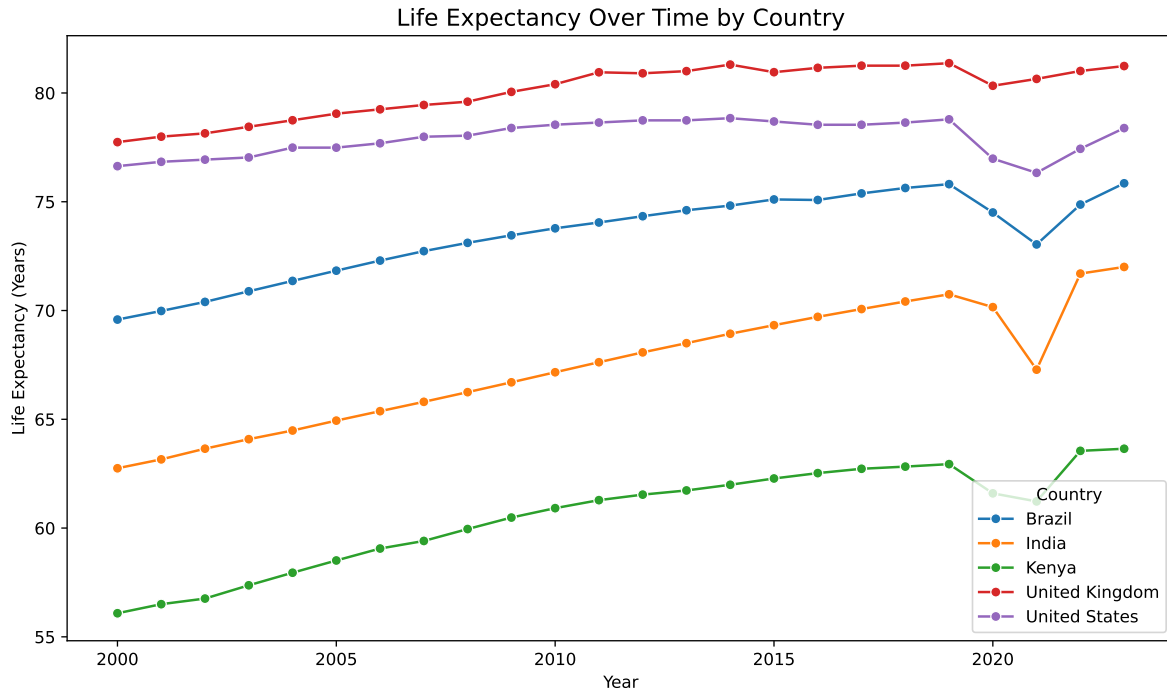
Figure 1: Life Expectancy Rates from 2000 - 2023

```python
# Average Life Expectancy Rate by Country

avg_life_exp = df.groupby("country")["life_expectancy"].mean().reset_index()

plt.figure(figsize=(8, 5))
sns.barplot(data=avg_life_exp, x="country", y="life_expectancy")
plt.title("Average Life Expectancy (2000-2023) by Country")
plt.ylabel("Average Life Expectancy (Years)")
plt.xlabel("Country")
plt.tight_layout()
plt.show()
```
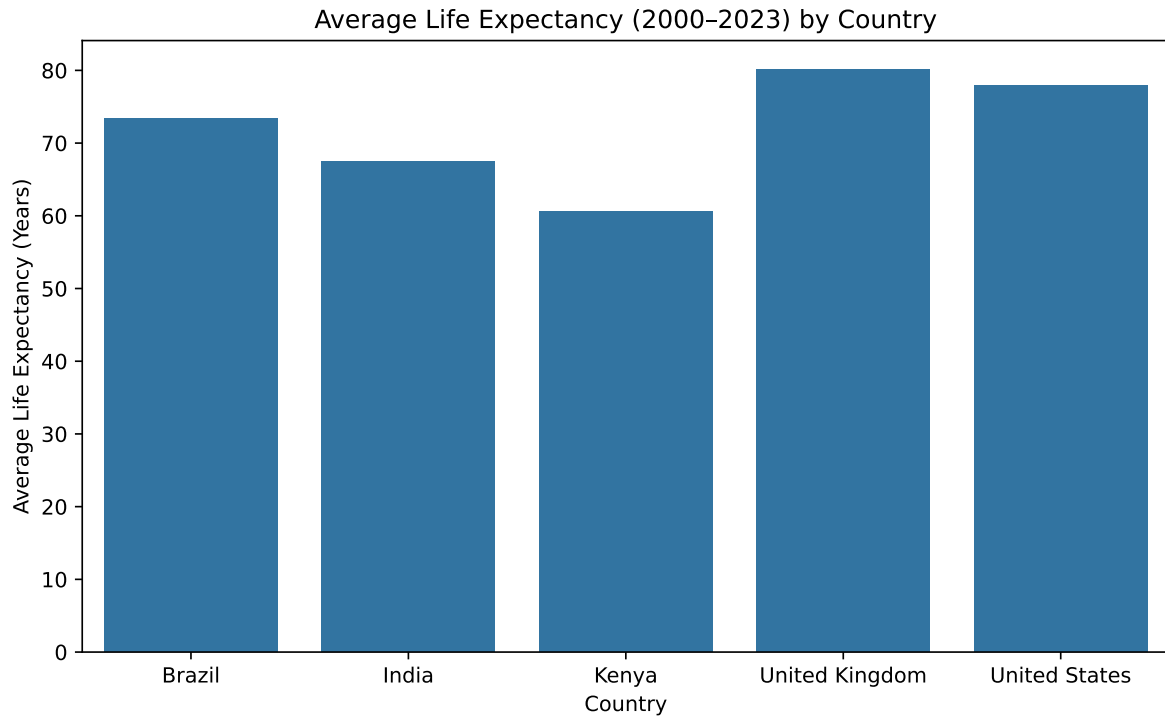
Figure 2: Average Life Expectancy Rates from 2000 - 2023

```
# Average Life Expectancy by Country

df.groupby('country')['life_expectancy'].mean()
```

```
country
Brazil            73.437500
India             67.453458
Kenya             60.534917
United Kingdom    80.094104
United States     77.931606
Name: life_expectancy, dtype: float64
```
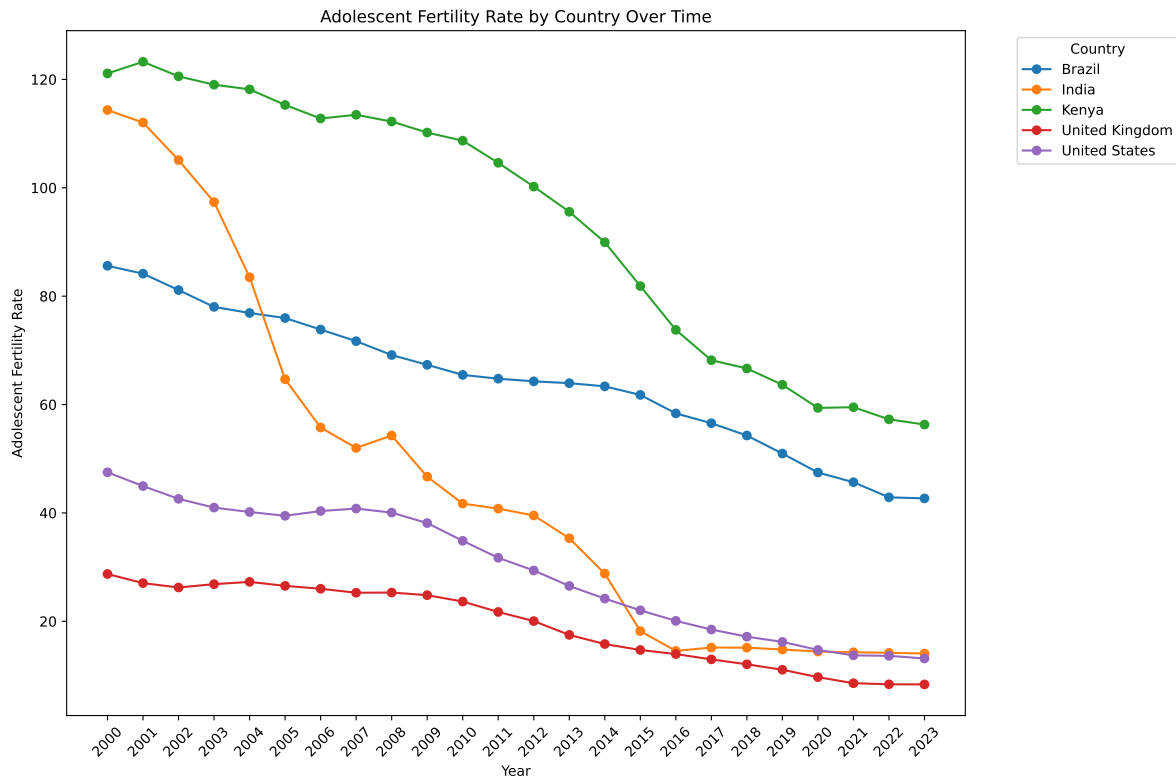
Average Life Expectancy Rates from 2000 - 2023

Adolescent Fertility Analysis

```python
# Adolescent Fertility Rate by Country Over Time

# Prepare the data for plotting
pivot_df = df.pivot(index='year', columns='country', values='adolescent_fertility')

# Plot the line graph
plt.figure(figsize=(12, 8))
pivot_df.plot(ax=plt.gca(), marker='o')
plt.title('Adolescent Fertility Rate by Country Over Time')
plt.xlabel('Year')
plt.ylabel('Adolescent Fertility Rate')
plt.legend(title='Country', bbox_to_anchor=(1.05, 1), loc='upper left')
plt.xticks(pivot_df.index, rotation=45)
plt.tight_layout()
plt.show()
```



```python
# Average Adolescent Fertility Rate by Country

df.groupby('country')['adolescent_fertility'].mean()
```

```
country
Brazil            64.429292
India             46.114583
Kenya             93.824000
United Kingdom    19.276250
United States     29.621542
Name: adolescent_fertility, dtype: float64
```

Average Adolescent Fertility Rates from 2000 - 2023

```python
# Adolescent Fertility Rate and Secondary School Enrollment

# Prepare the data for plotting
pivot_df_adolescent_fertility = df.pivot(index='year', columns='country', values='adolescent_
pivot_df_secondary_school_enrollment = df.pivot(index='year', columns='country', values='seco

# Plot the graphs
fig, axes = plt.subplots(1, 2, figsize=(14, 6), sharex=True, sharey=True)

# India
axes[0].plot(
    pivot_df_adolescent_fertility.index,
    pivot_df_adolescent_fertility['India'],
    marker='o',
    label='Adolescent Fertility Rate',
    color='tab:blue'
)
axes[0].plot(
    pivot_df_secondary_school_enrollment.index,
    pivot_df_secondary_school_enrollment['India'],
    marker='s',
    label='Secondary School Enrollment',
    color='tab:orange'
)
axes[0].set_title('India')
axes[0].set_xlabel('Year')
axes[0].set_ylabel('Rate')
axes[0].legend()
axes[0].tick_params(axis='x', rotation=45)
```

```
# United Kingdom
axes[1].plot(
    pivot_df_adolescent_fertility.index,
    pivot_df_adolescent_fertility['United Kingdom'],
    marker='o',
    label='Adolescent Fertility Rate',
    color='tab:blue'
)
axes[1].plot(
    pivot_df_secondary_school_enrollment.index,
    pivot_df_secondary_school_enrollment['United Kingdom'],
    marker='s',
    label='Secondary School Enrollment',
    color='tab:orange'
)
axes[1].set_title('United Kingdom')
axes[1].set_xlabel('Year')
axes[1].legend()
axes[1].tick_params(axis='x', rotation=45)

fig.suptitle('Adolescent Fertility Rate and Secondary School Enrollment\n(India and United K
plt.tight_layout(rect=[0, 0.03, 1, 0.95])
plt.show()
```
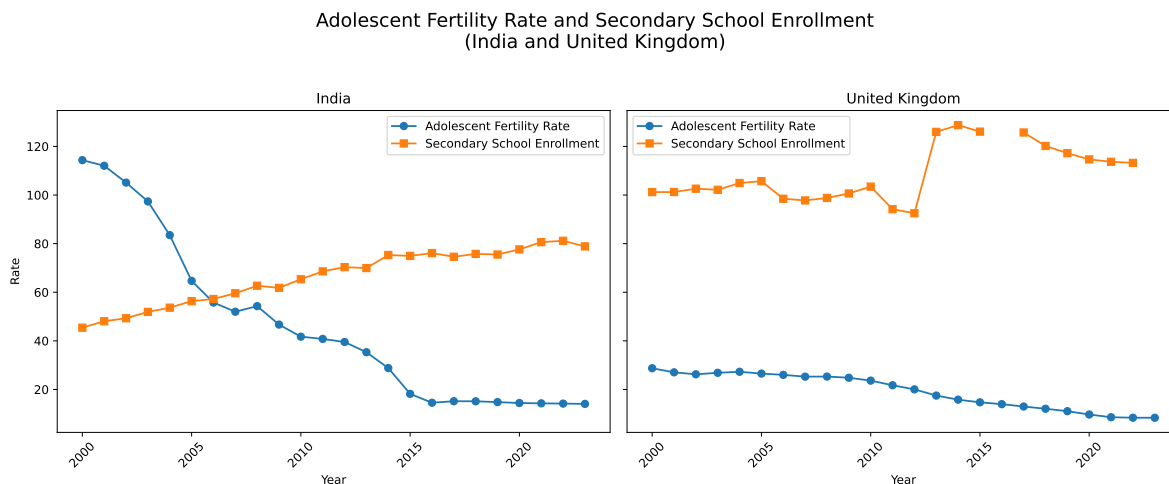

Figure 3: Adolescent Fertility and Secondary School Enrollment Rates: India and United Kingdom

Under-5 Mortality Rate Analysis

```
#Under 5 Mortality Rate by Country Over Time

# Prepare the data for plotting
pivot_df = df.pivot(index='year', columns='country', values='under5_mortality')

# Plot the line graph
plt.figure(figsize=(12, 8))
pivot_df.plot(ax=plt.gca(), marker='o')
plt.title('Under 5 Mortality Rate by Country Over Time')
plt.xlabel('Year')
plt.ylabel('Under 5 Mortality Rate')
plt.legend(title='Country', bbox_to_anchor=(1.05, 1), loc='upper left')
plt.xticks(pivot_df.index, rotation=45)
plt.tight_layout()
plt.show()
```
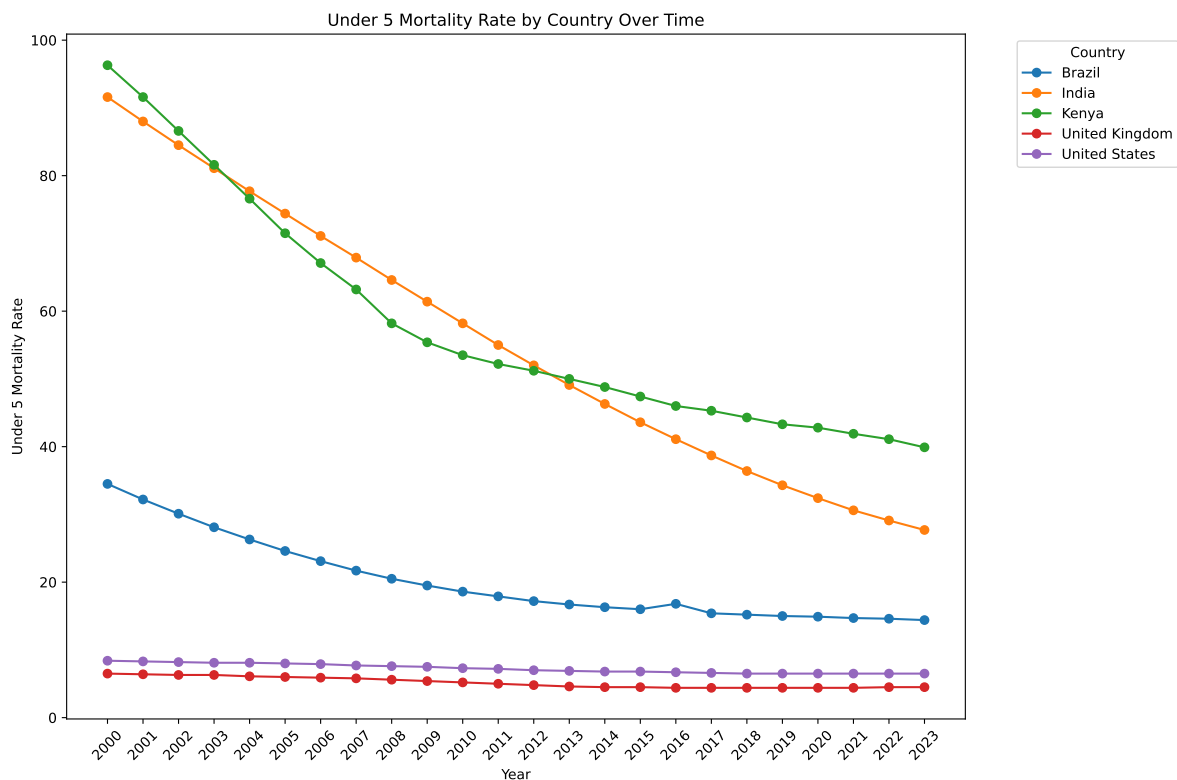

Figure 4: Under-5 Mortality Rates from 2000 - 2023

```
# Average Under 5 Mortality Rate by Country

df.groupby('country')['under5_mortality'].mean()
```

```
country
Brazil            20.179167
India             55.700000
Kenya             58.158333
United Kingdom     5.179167
United States      7.254167
Name: under5_mortality, dtype: float64
```

Average Under-5 Mortality Rates from 2000 - 2023

```
# Under 5 Mortality Rate and Adolescent Fertility Rate

# Prepare the data for plotting
pivot_df_under5_mortality = df.pivot(index='year', columns='country', values='under5_mortalit
pivot_df_adolescent_fertility = df.pivot(index='year', columns='country', values='adolescent_

# Plot the graphs
fig, axes = plt.subplots(1, 2, figsize=(14, 6), sharex=True, sharey=True)

# Kenya
axes[0].plot(
    pivot_df_adolescent_fertility.index,
    pivot_df_adolescent_fertility['Kenya'],
    marker='o',
    label='Adolescent Fertility Rate',
    color='tab:blue'
)
axes[0].plot(
    pivot_df_under5_mortality.index,
    pivot_df_under5_mortality['Kenya'],
    marker='s',
    label='Under-5 Mortality Rate',
    color='tab:orange'
)
axes[0].set_title('Kenya')
axes[0].set_xlabel('Year')
axes[0].set_ylabel('Rate')
```

```python
axes[0].legend()
axes[0].tick_params(axis='x', rotation=45)

# United Kingdom
axes[1].plot(
    pivot_df_adolescent_fertility.index,
    pivot_df_adolescent_fertility['United Kingdom'],
    marker='o',
    label='Adolescent Fertility Rate',
    color='tab:blue'
)
axes[1].plot(
    pivot_df_under5_mortality.index,
    pivot_df_under5_mortality['United Kingdom'],
    marker='s',
    label='Under-5 Mortality Rate',
    color='tab:orange'
)
axes[1].set_title('United Kingdom')
axes[1].set_xlabel('Year')
axes[1].legend()
axes[1].tick_params(axis='x', rotation=45)

fig.suptitle('Under-5 Mortality and Adolescent Fertility Rates\n(Kenya and United Kingdom)',
plt.tight_layout(rect=[0, 0.03, 1, 0.95])
plt.show()
```
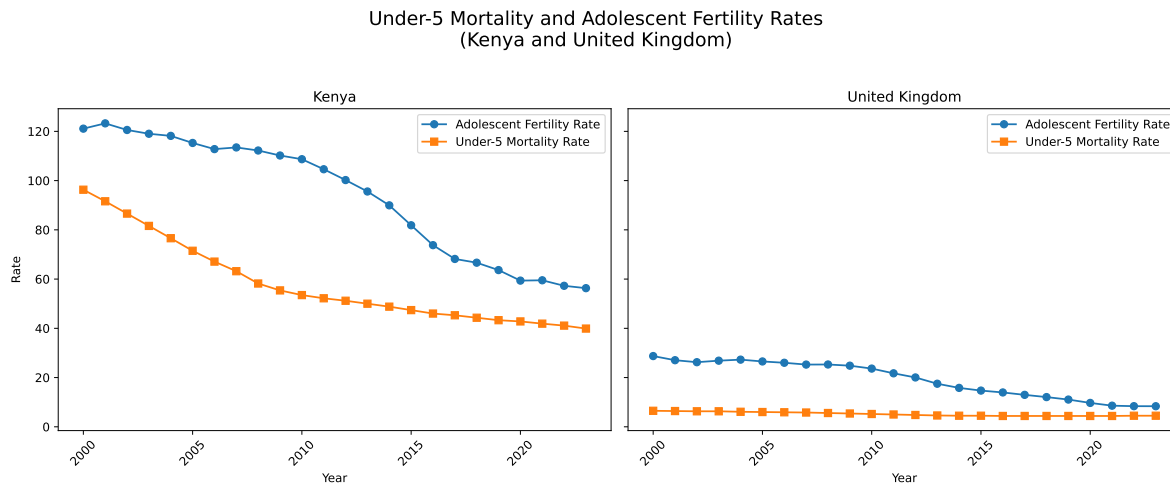
Figure 5: Under-5 Mortality & Adolescent Fertility Rates: Kenya and United Kingdom

Life Expectancy, Adolescent Fertility, and Under-5 Mortality

```python
# Normalize the life expectancy column to see clearer changes
# 0.01 is added to avoid a minimum value of 0
df['life_expectancy_norm'] = 0.01 + (df['life_expectancy'] - df['life_expectancy'].min()) /

# Create an animated scatter plot/bubble chart
fig = px.scatter(
    df,
    x = "under5_mortality",
    y = "adolescent_fertility",
    title = "Life Expectancy, Under-5 Mortality, and Adolescent Fertility Rate Over Time",
    size = 'life_expectancy_norm',
    color = 'country',
    color_discrete_map = {
        'Brazil': '#1f77b4',
        'India': '#ff7f0e',
        'Kenya': 'green',
        'United Kingdom': 'red',
        'United States': '#9467bd'
    },
    hover_name = 'country',
    size_max = 60,
    animation_frame = 'year',
```

```
    animation_group ='country',
    labels={
        "under5_mortality": "Under-5 Mortality Rate",
        "adolescent_fertility": "Adolescent Fertility Rate",
        "life_expectancy_norm": "Life Expectancy (Normalized)"
    }
)

fig.show()
```

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Life Expectancy, Adolescent Fertility, and Under-5 Mortality from 2000 - 2023

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