Global Unemployment Trends (2014–2024)

June 26, 2025

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
```

[27]:
```
df = pd.read_csv('../data/global_unemployment.csv')
print(df.head())
print(df.info())
```

```
  country_name                    indicator_name     sex age_group  \
0  Afghanistan  Unemployment rate by sex and age  Female     15-24
1  Afghanistan  Unemployment rate by sex and age  Female       25+
2  Afghanistan  Unemployment rate by sex and age  Female  Under 15
3  Afghanistan  Unemployment rate by sex and age    Male     15-24
4  Afghanistan  Unemployment rate by sex and age    Male       25+

  age_categories    2014    2015    2016    2017    2018    2019    2020  \
0          Youth  13.340  15.974  18.570  21.137  20.649  20.154  21.228
1         Adults   8.576   9.014   9.463   9.920  11.223  12.587  14.079
2       Children  10.306  11.552  12.789  14.017  14.706  15.418  16.783
3          Youth   9.206  11.502  13.772  16.027  15.199  14.361  14.452
4         Adults   6.463   6.879   7.301   7.728   7.833   7.961   8.732

     2021    2022    2023    2024
0  21.640  30.561  32.200  33.332
1  14.415  23.818  26.192  28.298
2  17.134  26.746  29.193  30.956
3  15.099  16.655  18.512  19.770
4   9.199  11.357  12.327  13.087
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1134 entries, 0 to 1133
Data columns (total 16 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   country_name    1134 non-null   object
 1   indicator_name  1134 non-null   object
 2   sex             1134 non-null   object
 3   age_group       1134 non-null   object
```

```
 4   age_categories  1134 non-null   object
 5   2014            1134 non-null   float64
 6   2015            1134 non-null   float64
 7   2016            1134 non-null   float64
 8   2017            1134 non-null   float64
 9   2018            1134 non-null   float64
 10  2019            1134 non-null   float64
 11  2020            1134 non-null   float64
 12  2021            1134 non-null   float64
 13  2022            1128 non-null   float64
 14  2023            1122 non-null   float64
 15  2024            1122 non-null   float64
dtypes: float64(11), object(5)
memory usage: 141.9+ KB
None
```

[109]:
```
# 1.      (   )
country_to_continent = {
    # Africa
    'Algeria': 'Africa', 'Angola': 'Africa', 'Benin': 'Africa', 'Botswana':␣
↪'Africa', 'Burkina Faso': 'Africa',
    'Burundi': 'Africa', 'Cameroon': 'Africa', 'Cape Verde': 'Africa', 'Central␣
↪African Republic': 'Africa',
    'Chad': 'Africa', 'Comoros': 'Africa', 'Congo': 'Africa', 'Democratic␣
↪Republic of the Congo': 'Africa',
    'Djibouti': 'Africa', 'Egypt': 'Africa', 'Equatorial Guinea': 'Africa',␣
↪'Eritrea': 'Africa', 'Eswatini': 'Africa',
    'Ethiopia': 'Africa', 'Gabon': 'Africa', 'Gambia': 'Africa', 'Ghana':␣
↪'Africa', 'Guinea': 'Africa',
    'Guinea-Bissau': 'Africa', 'Ivory Coast': 'Africa', 'Kenya': 'Africa',␣
↪'Lesotho': 'Africa', 'Liberia': 'Africa',
    'Libya': 'Africa', 'Madagascar': 'Africa', 'Malawi': 'Africa', 'Mali':␣
↪'Africa', 'Mauritania': 'Africa',
    'Mauritius': 'Africa', 'Morocco': 'Africa', 'Mozambique': 'Africa',␣
↪'Namibia': 'Africa', 'Niger': 'Africa',
    'Nigeria': 'Africa', 'Rwanda': 'Africa', 'Sao Tome and Principe': 'Africa',␣
↪'Senegal': 'Africa',
    'Seychelles': 'Africa', 'Sierra Leone': 'Africa', 'Somalia': 'Africa',␣
↪'South Africa': 'Africa',
    'South Sudan': 'Africa', 'Sudan': 'Africa', 'Tanzania': 'Africa', 'Togo':␣
↪'Africa', 'Tunisia': 'Africa',
    'Uganda': 'Africa', 'Zambia': 'Africa', 'Zimbabwe': 'Africa',

    # Asia
    'Afghanistan': 'Asia', 'Armenia': 'Asia', 'Azerbaijan': 'Asia', 'Bahrain':␣
↪'Asia', 'Bangladesh': 'Asia',
```

```
    'Bhutan': 'Asia', 'Brunei': 'Asia', 'Cambodia': 'Asia', 'China': 'Asia',␣
↪'Cyprus': 'Asia', 'Georgia': 'Asia',
    'India': 'Asia', 'Indonesia': 'Asia', 'Iran': 'Asia', 'Iraq': 'Asia',␣
↪'Israel': 'Asia', 'Japan': 'Asia',
    'Jordan': 'Asia', 'Kazakhstan': 'Asia', 'Kuwait': 'Asia', 'Kyrgyzstan':␣
↪'Asia', 'Laos': 'Asia', 'Lebanon': 'Asia',
    'Malaysia': 'Asia', 'Maldives': 'Asia', 'Mongolia': 'Asia', 'Myanmar':␣
↪'Asia', 'Nepal': 'Asia', 'North Korea': 'Asia',
    'Oman': 'Asia', 'Pakistan': 'Asia', 'Palestine': 'Asia', 'Philippines':␣
↪'Asia', 'Qatar': 'Asia', 'Russia': 'Asia',
    'Saudi Arabia': 'Asia', 'Singapore': 'Asia', 'South Korea': 'Asia', 'Sri␣
↪Lanka': 'Asia', 'Syria': 'Asia',
    'Tajikistan': 'Asia', 'Thailand': 'Asia', 'Timor-Leste': 'Asia', 'Turkey':␣
↪'Asia', 'Turkmenistan': 'Asia',
    'United Arab Emirates': 'Asia', 'Uzbekistan': 'Asia', 'Vietnam': 'Asia',␣
↪'Yemen': 'Asia',

    # Europe
    'Albania': 'Europe', 'Andorra': 'Europe', 'Armenia': 'Europe', 'Austria':␣
↪'Europe', 'Azerbaijan': 'Europe',
    'Belarus': 'Europe', 'Belgium': 'Europe', 'Bosnia and Herzegovina':␣
↪'Europe', 'Bulgaria': 'Europe',
    'Croatia': 'Europe', 'Cyprus': 'Europe', 'Czech Republic': 'Europe',␣
↪'Denmark': 'Europe', 'Estonia': 'Europe',
    'Finland': 'Europe', 'France': 'Europe', 'Georgia': 'Europe', 'Germany':␣
↪'Europe', 'Greece': 'Europe',
    'Hungary': 'Europe', 'Iceland': 'Europe', 'Ireland': 'Europe', 'Italy':␣
↪'Europe', 'Kosovo': 'Europe',
    'Latvia': 'Europe', 'Liechtenstein': 'Europe', 'Lithuania': 'Europe',␣
↪'Luxembourg': 'Europe', 'Malta': 'Europe',
    'Moldova': 'Europe', 'Monaco': 'Europe', 'Montenegro': 'Europe',␣
↪'Netherlands': 'Europe', 'North Macedonia': 'Europe',
    'Norway': 'Europe', 'Poland': 'Europe', 'Portugal': 'Europe', 'Romania':␣
↪'Europe', 'Russia': 'Europe',
    'San Marino': 'Europe', 'Serbia': 'Europe', 'Slovakia': 'Europe', 'Slovenia':
↪ 'Europe', 'Spain': 'Europe',
    'Sweden': 'Europe', 'Switzerland': 'Europe', 'Ukraine': 'Europe', 'United␣
↪Kingdom': 'Europe', 'Vatican City': 'Europe',

    # North America
    'Antigua and Barbuda': 'North America', 'Bahamas': 'North America',␣
↪'Barbados': 'North America',
    'Belize': 'North America', 'Canada': 'North America', 'Costa Rica': 'North␣
↪America', 'Cuba': 'North America',
```

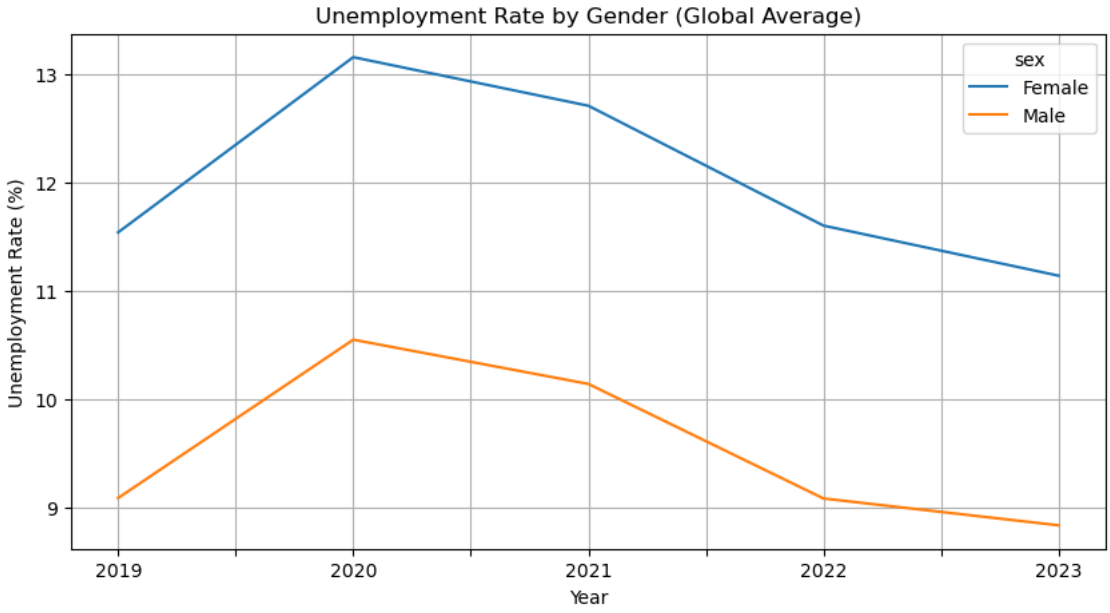
```
    'Dominica': 'North America', 'Dominican Republic': 'North America', 'El␣
↪Salvador': 'North America',
    'Grenada': 'North America', 'Guatemala': 'North America', 'Haiti': 'North␣
↪America', 'Honduras': 'North America',
    'Jamaica': 'North America', 'Mexico': 'North America', 'Nicaragua': 'North␣
↪America', 'Panama': 'North America',
    'Saint Kitts and Nevis': 'North America', 'Saint Lucia': 'North America',␣
↪'Saint Vincent and the Grenadines': 'North America',
    'Trinidad and Tobago': 'North America', 'United States': 'North America',

    # South America
    'Argentina': 'South America', 'Bolivia': 'South America', 'Brazil': 'South␣
↪America', 'Chile': 'South America',
    'Colombia': 'South America', 'Ecuador': 'South America', 'Guyana': 'South␣
↪America', 'Paraguay': 'South America',
    'Peru': 'South America', 'Suriname': 'South America', 'Uruguay': 'South␣
↪America', 'Venezuela': 'South America',

    # Oceania
    'Australia': 'Oceania', 'Fiji': 'Oceania', 'Kiribati': 'Oceania', 'Marshall␣
↪Islands': 'Oceania',
    'Micronesia': 'Oceania', 'Nauru': 'Oceania', 'New Zealand': 'Oceania',␣
↪'Palau': 'Oceania',
    'Papua New Guinea': 'Oceania', 'Samoa': 'Oceania', 'Solomon Islands':␣
↪'Oceania', 'Tonga': 'Oceania',
    'Tuvalu': 'Oceania', 'Vanuatu': 'Oceania'
}

# 2.    DataFrame
df['continent'] = df['country_name'].map(country_to_continent)
```

[111]:
```
# Missing values are checked for each column
print("Missing values:\n", df.isna().sum())
```

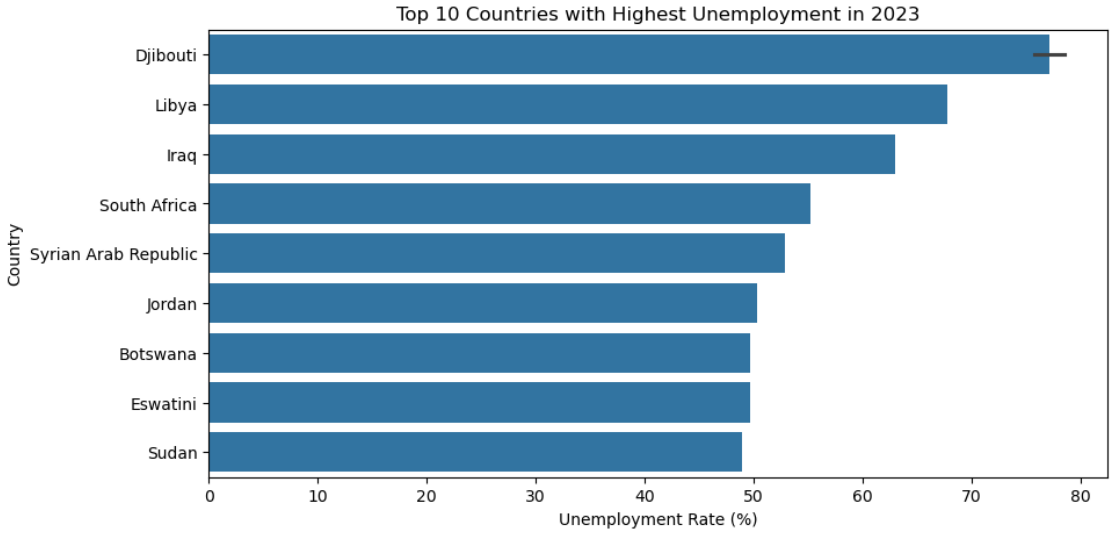
```
Missing values:
 country_name         0
indicator_name       0
sex                  0
age_group            0
age_categories       0
2014                 0
2015                 0
2016                 0
2017                 0
2018                 0
2019                 0
2020                 0
```

```
2021                0
2022                6
2023               12
2024               12
delta_2019_2021     0
continent         150
dtype: int64
```

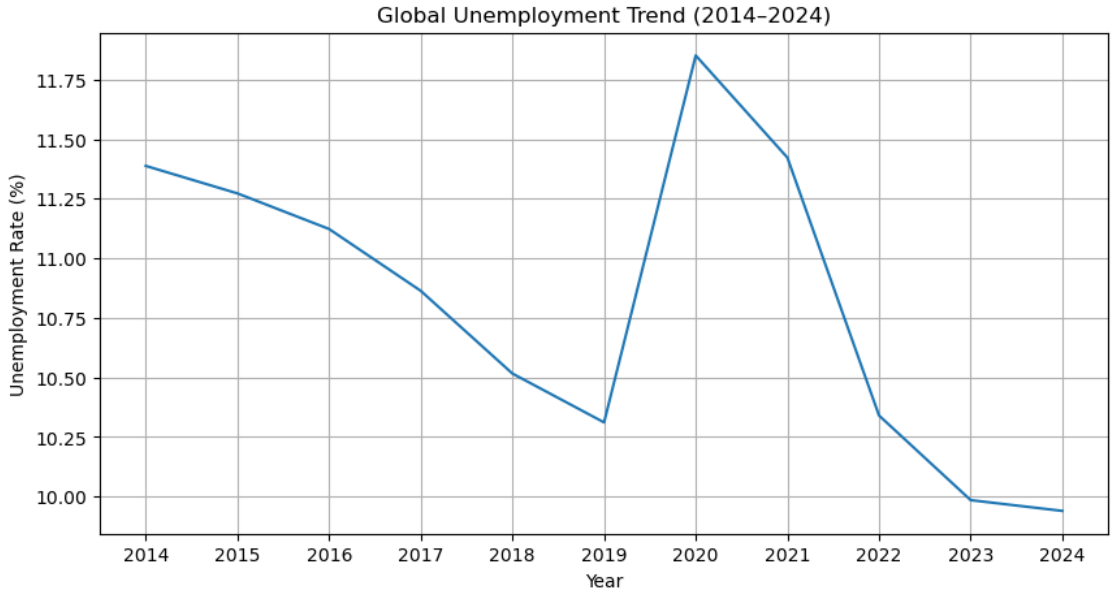
[113]:
```
# The difference between males and females is analyzed
gender_avg = df.groupby('sex')[years].mean().T
gender_avg.plot(figsize=(10,5))
plt.title("Unemployment Rate by Gender (Global Average)")
plt.xlabel("Year")
plt.ylabel("Unemployment Rate (%)")
plt.grid(True)
plt.show()
```



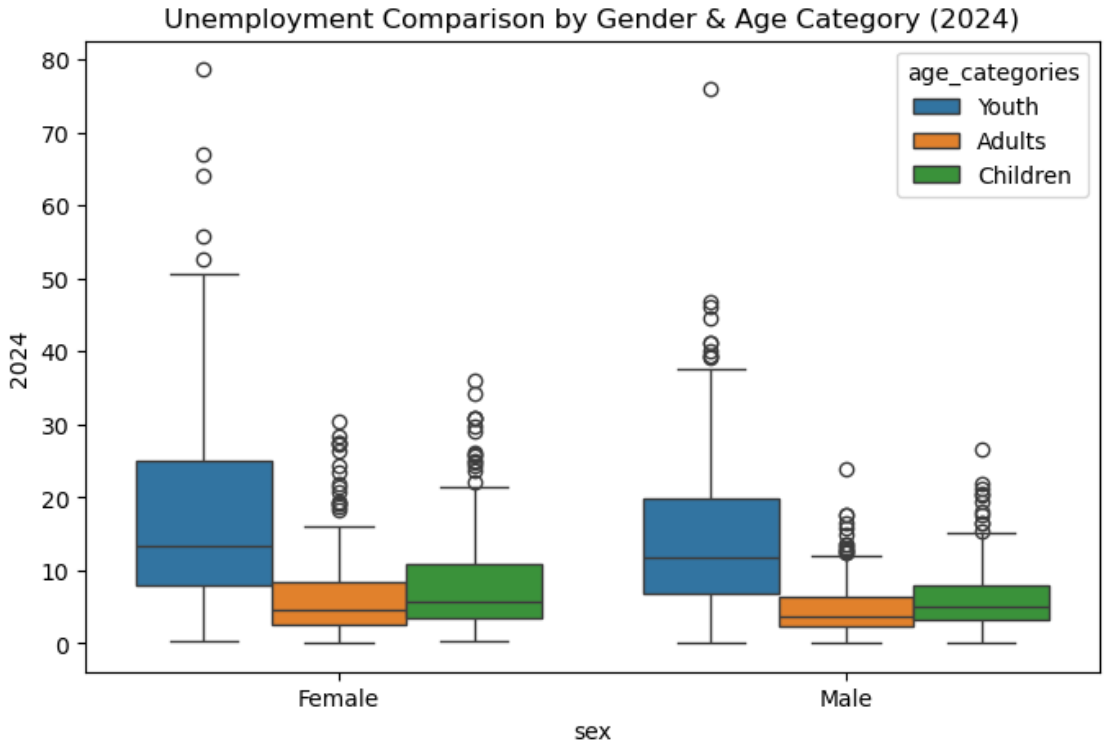
[53]:
```
# The countries with the highest unemployment rates in the year 2023 are␣
↪identified
top_2023 = df[['country_name', '2023']].sort_values(by='2023', ascending=False).
↪head(10)

plt.figure(figsize=(10,5))
sns.barplot(data=top_2023, x='2023', y='country_name')
plt.title("Top 10 Countries with Highest Unemployment in 2023")
plt.xlabel("Unemployment Rate (%)")
plt.ylabel("Country")
plt.show()
```



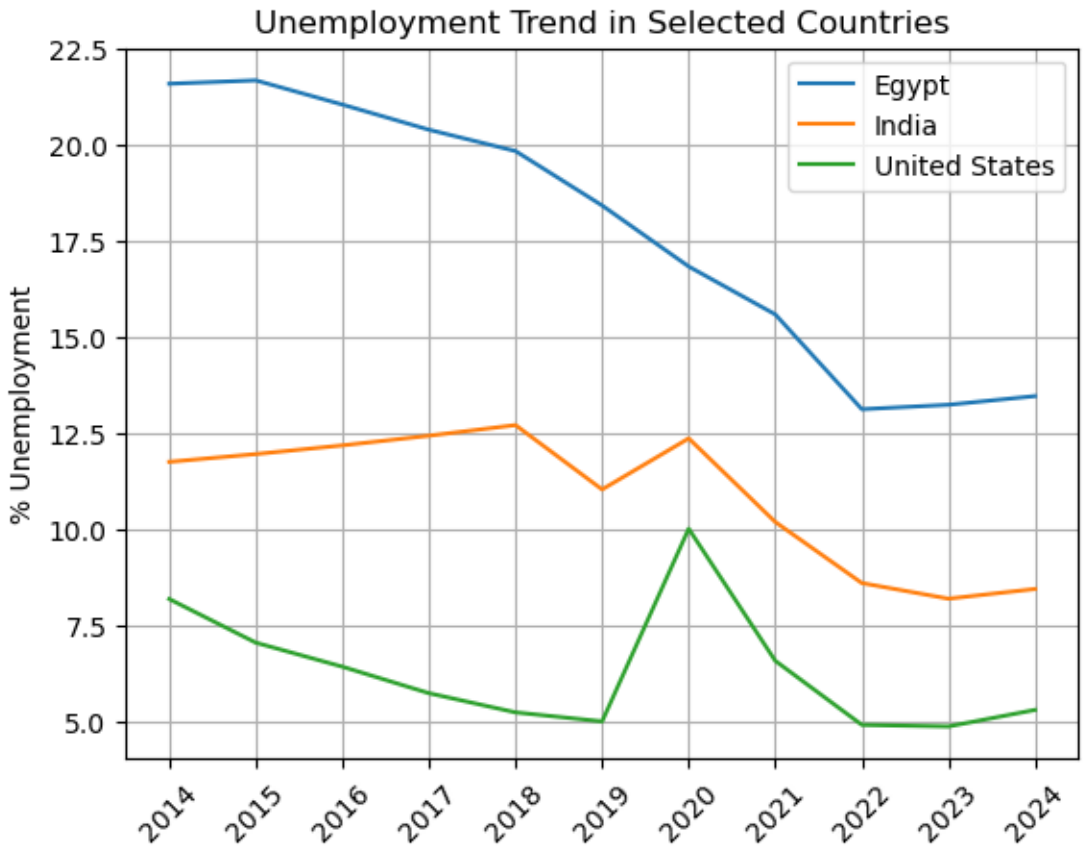
[67]:
```
# The global unemployment trend over time is analyzed and visualized
years = [str(y) for y in range(2014, 2025)]
global_trend = df[years].mean()

plt.figure(figsize=(10,5))
sns.lineplot(x=years, y=global_trend)
plt.title("Global Unemployment Trend (2014-2024)")
plt.ylabel("Unemployment Rate (%)")
plt.xlabel("Year")
plt.grid(True)
plt.show()
```



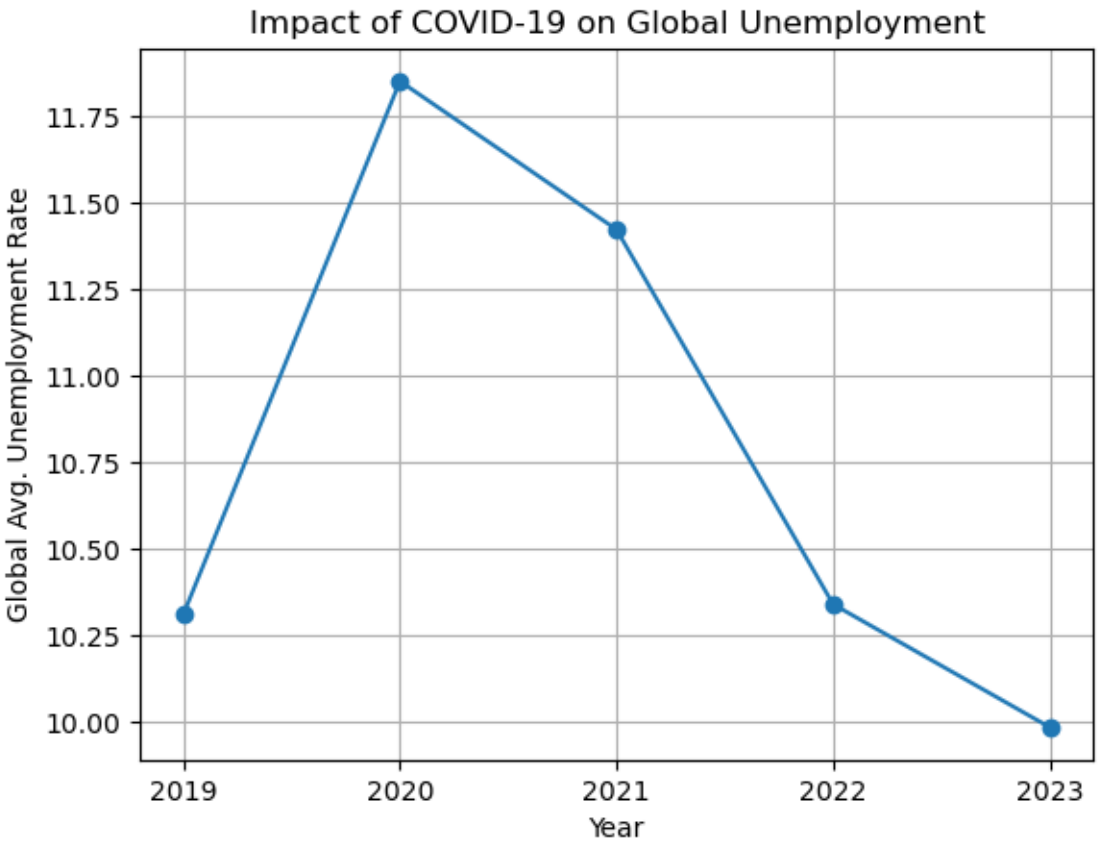
[71]:
```
# The different age groups (children, youth, adults) are compared
latest = df[['sex', 'age_categories', '2024']].dropna()
plt.figure(figsize=(8,5))
sns.boxplot(data=latest, x='sex', y='2024', hue='age_categories')
plt.title("Unemployment Comparison by Gender & Age Category (2024)")
plt.show()
```



[75]:
```
# Changes in unemployment rates over time are tracked for specific countries (e.
 ↪g., Egypt, India, United States)
selected_countries = ['Egypt', 'India', 'United States']
for country in selected_countries:
    trend = df[df['country_name'] == country][years].mean()
    plt.plot(years, trend, label=country)

plt.title("Unemployment Trend in Selected Countries")
plt.ylabel("% Unemployment")
plt.legend()
plt.xticks(rotation=45)
plt.grid(True)
plt.show()
```



[93]:
```
# The global unemployment rates before and after the COVID-19 pandemic are␣
↪compared
years = ['2019', '2020', '2021', '2022', '2023']
global_avg = df[years].mean()

plt.plot(years, global_avg, marker='o')
plt.title("Impact of COVID-19 on Global Unemployment")
plt.ylabel("Global Avg. Unemployment Rate")
plt.xlabel("Year")
plt.grid(True)
plt.show()
```



[189]:
```
#The countries that succeeded in reducing unemployment (top improvers) were␣
 ↪analyzed.
df['delta_2014_2024'] = df['2024'] - df['2014']
improvers = df.groupby('country_name')['delta_2014_2024'].mean().sort_values()
print(f"\nThe countries that succeeded in reducing unemployment (top improvers)␣
 ↪were analyzed.:")

print(improvers.head(20))
```

```
The countries that succeeded in reducing unemployment (top improvers) were
analyzed.:
country_name
Bosnia and Herzegovina   -21.190167
Greece                   -21.084833
North Macedonia          -19.211000
Serbia                   -17.562667
Spain                    -16.048500
Croatia                  -15.548667
Cyprus                   -12.380833
Puerto Rico              -10.260833
Portugal                 -10.115167
Bulgaria                  -9.542500
Italy                     -9.056000
Saudi Arabia              -9.027667
Poland                    -8.437833
Ireland                   -8.281833
Slovenia                  -8.251500
Egypt                     -8.128333
Albania                   -8.078500
Slovakia                  -6.657333
Saint Lucia               -5.944667
Barbados                  -5.913000
Name: delta_2014_2024, dtype: float64
```

[195]:
```
#Countries that recorded significant increases in unemployment were identified.

worseners = df.groupby('country_name')['delta_2014_2024'].mean().
 ↪sort_values(ascending=False)
print(f"\nCountries that recorded significant increases in unemployment were␣
 ↪identified.:")
print(worseners.head(20))
```

```
Countries that recorded significant increases in unemployment were identified.:
```

```
country_name
Afghanistan     14.251333
Iraq             8.853500
Bhutan           8.752333
Jordan           7.757667
South Africa     6.489167
Botswana         6.217333
Pakistan         5.025000
Zimbabwe         4.969167
Yemen            4.682500
Algeria          4.436833
Sri Lanka        4.384500
Panama           4.251667
Sudan            4.007000
Myanmar          3.822000
Tunisia          3.771000
Chile            3.585333
Rwanda           3.573833
Kenya            3.407167
Uruguay          3.294667
Mauritania       2.906833
Name: delta_2014_2024, dtype: float64
```

[209]:
```
df['std_dev'] = df[[str(y) for y in range(2014, 2025)]].std(axis=1)
stable_countries = df.groupby('country_name')['std_dev'].mean().sort_values()
print(stable_countries.head(20))  #
```

```
country_name
Niger                                   0.106724
Qatar                                   0.201380
Benin                                   0.218305
Korea, Democratic People's Republic of  0.219126
Cambodia                                0.234311
Chad                                    0.239732
Cameroon                                0.242603
Taiwan, China                           0.243201
Papua New Guinea                        0.245013
Guinea-Bissau                           0.249127
Tanzania, United Republic of            0.266309
Madagascar                              0.275571
Eritrea                                 0.282615
Kazakhstan                              0.291792
Malawi                                  0.318720
Mozambique                              0.323377
Central African Republic                0.328979
Burundi                                 0.338058
Burkina Faso                            0.355526
Turkmenistan                            0.381902
```

```
Name: std_dev, dtype: float64
```

[145]:
```
# The 10 countries with the largest decreases in unemployment between 2019 and 2023 were identified.

df['change_2019_2023'] = df['2023'] - df['2019']
improved_countries = df.sort_values('change_2019_2023').head(10)
print(improved_countries[['country_name', '2019', '2023', 'change_2019_2023']])
```

```
        country_name    2019    2023  change_2019_2023
870     Saudi Arabia  51.002  27.319           -23.683
294            Egypt  52.014  36.599           -15.415
882           Serbia  29.907  17.950           -11.957
126           Brazil  31.846  20.607           -11.239
393           Greece  32.581  21.858           -10.723
24         Argentina  28.522  20.063            -8.459
234       Costa Rica  36.008  27.583            -8.425
747  North Macedonia  33.357  24.987            -8.370
296            Egypt  21.343  13.434            -7.909
648        Mauritius  28.615  20.714            -7.901
```

[211]:
```
#Countries where unemployment sharply increased after the pandemic were identified.

worsened_countries = df.sort_values('change_2019_2023', ascending=False).head(20)
print(worsened_countries[['country_name', '2019', '2023', 'change_2019_2023']])
```

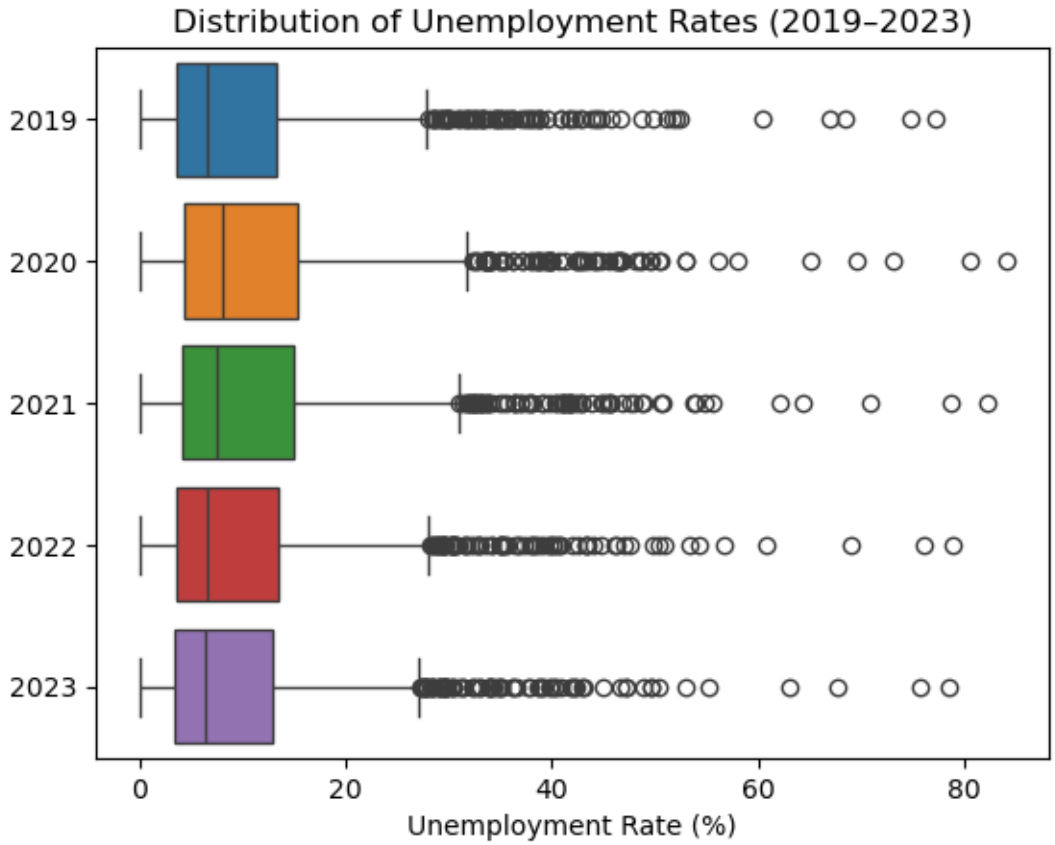
```
    country_name    2019    2023  change_2019_2023
102       Bhutan  13.387  32.987            19.600
105       Bhutan   9.813  25.725            15.912
120     Botswana  34.908  49.696            14.788
2     Afghanistan  15.418  29.193            13.775
1     Afghanistan  12.587  26.192            13.605
0     Afghanistan  20.154  32.200            12.046
693       Myanmar   1.266  10.175             8.909
690       Myanmar   1.398   9.221             7.823
321       Estonia  10.440  18.083             7.643
948     Sri Lanka  27.350  34.980             7.630
903      Slovakia  14.050  20.345             6.295
840        Rwanda  16.676  22.963             6.287
828       Romania  17.534  23.669             6.135
951     Sri Lanka  16.617  22.459             5.842
207         China  11.567  17.353             5.786
594    Luxembourg  16.016  21.649             5.633
957         Sudan  28.311  33.920             5.609
843        Rwanda  15.409  20.890             5.481
513        Jordan  34.525  39.660             5.135
849  Saint Lucia  37.800  42.906             5.106
```

[213]:
```
# The countries with the highest unemployment rates for each year were␣
↪identified.
for year in years:
    top = df[['country_name', year]].sort_values(by=year, ascending=False).
↪head(10)
    print(f"\nTop 10 countries in unemployment for {year}:")
    print(top)
```

```
Top 10 countries in unemployment for 2020:
               country_name    2020
276                Djibouti  83.990
279                Djibouti  80.463
582                   Libya  73.061
756  Palestinian Territories  69.503
474                    Iraq  65.090
978    Syrian Arab Republic  58.048
324                Eswatini  56.030
510                  Jordan  53.017
12                  Algeria  52.886
327                Eswatini  50.607

Top 10 countries in unemployment for 2021:
               country_name    2021
276                Djibouti  82.135
279                Djibouti  78.706
582                   Libya  70.865
756  Palestinian Territories  64.249
474                    Iraq  62.128
978    Syrian Arab Republic  55.533
924             South Africa  54.883
510                  Jordan  53.977
324                Eswatini  53.667
120                Botswana  50.666

Top 10 countries in unemployment for 2022:
               country_name    2022
276                Djibouti  78.776
279                Djibouti  76.054
582                   Libya  69.032
474                    Iraq  60.859
756  Palestinian Territories  56.709
924             South Africa  54.332
978    Syrian Arab Republic  53.334
120                Botswana  50.836
324                Eswatini  50.427
510                  Jordan  49.751
```

```
Top 10 countries in unemployment for 2023:
             country_name    2023
276              Djibouti  78.541
279              Djibouti  75.734
582                 Libya  67.735
474                  Iraq  62.942
924          South Africa  55.231
978  Syrian Arab Republic  52.887
510                Jordan  50.263
120              Botswana  49.696
324              Eswatini  49.651
954                 Sudan  48.918
```

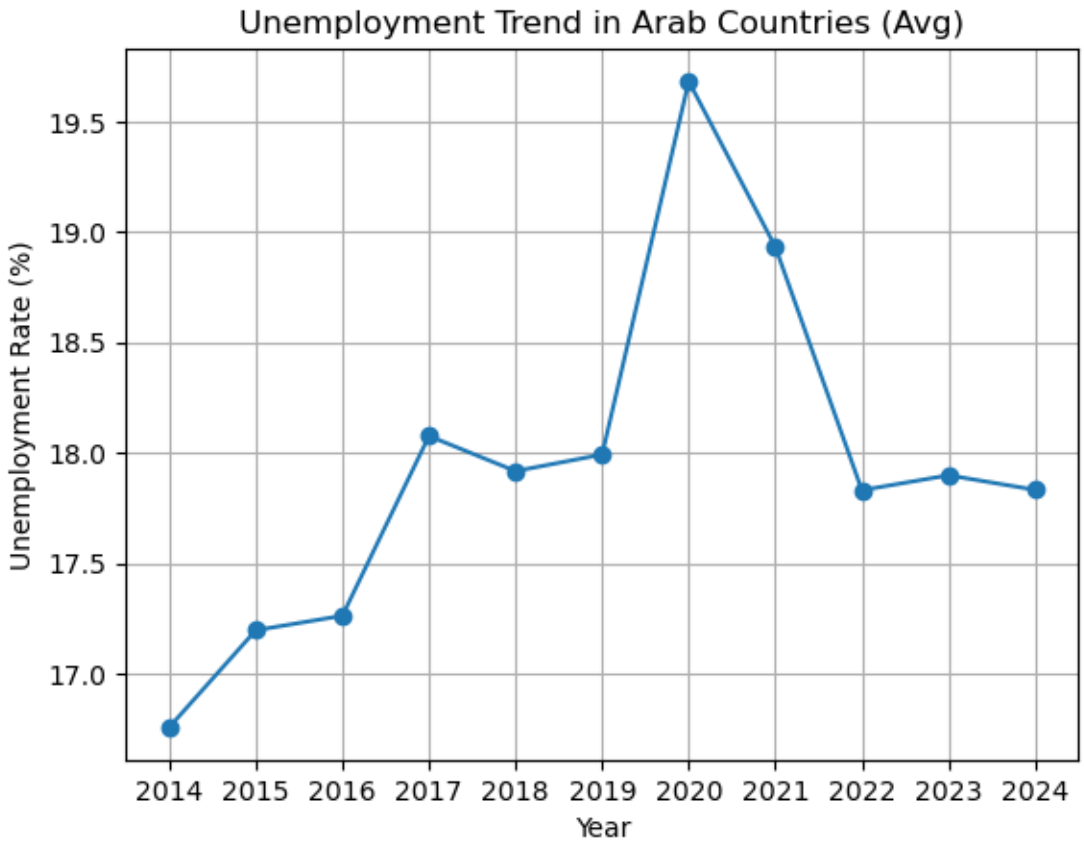
[157]:
```
# The global distribution of unemployment in a specific year was visualized␣
↪using a boxplot.

sns.boxplot(data=df[years], orient='h')
plt.title('Distribution of Unemployment Rates (2019-2023)')
plt.xlabel('Unemployment Rate (%)')
plt.show()
```



[215]:
```
# Countries that maintained relative stability (low standard deviation) were␣
↪identified.
df['std_dev'] = df[years].std(axis=1)
stable = df[df['std_dev'] < 1].sort_values('std_dev')
print(stable[['country_name', 'std_dev']].head(10))
```

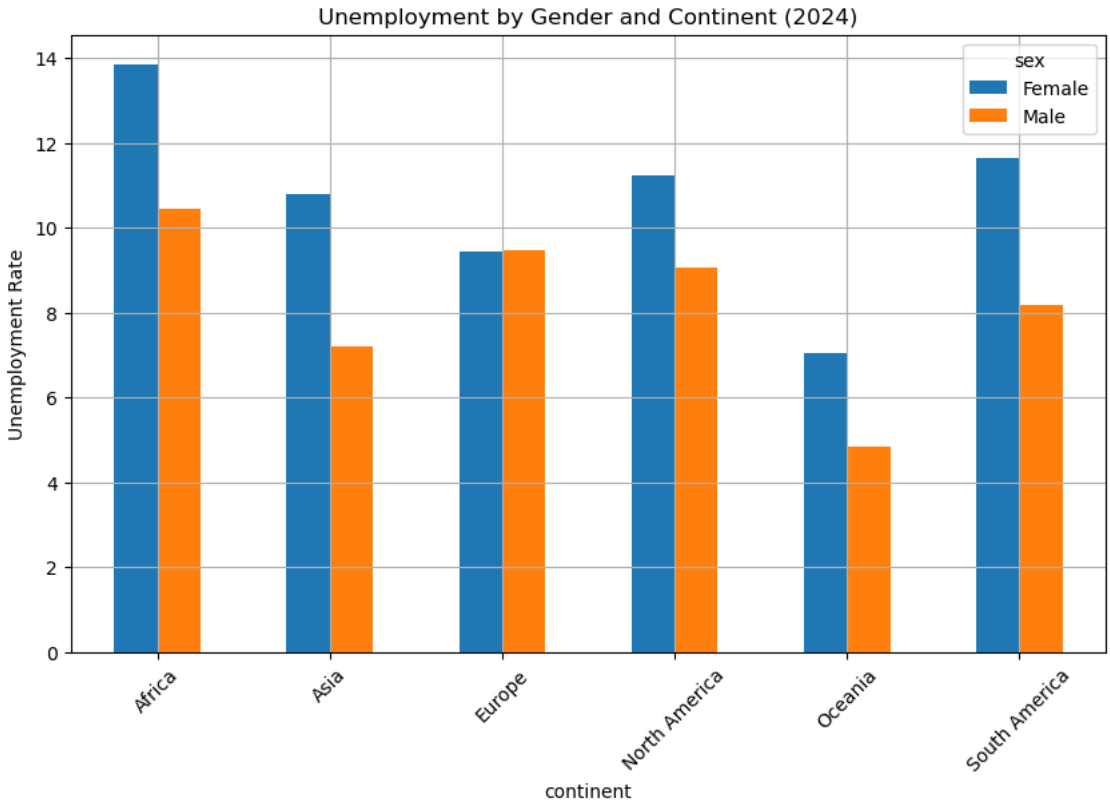
```
    country_name   std_dev
826        Qatar  0.004655
827        Qatar  0.005508
387        Ghana  0.040377
823        Qatar  0.044836
251         Cuba  0.055729
824        Qatar  0.056240
389        Ghana  0.057102
250         Cuba  0.062059
505        Japan  0.065936
374      Georgia  0.066066
```

[167]:
```
# Arab countries are filtered and analyzed separately from the global dataset
arab_countries = ['Algeria', 'Bahrain', 'Comoros', 'Djibouti', 'Egypt', 'Iraq',␣
↪'Jordan', 'Kuwait',
                  'Lebanon', 'Libya', 'Mauritania', 'Morocco', 'Oman',␣
↪'Palestine', 'Qatar',
                  'Saudi Arabia', 'Somalia', 'Sudan', 'Syria', 'Tunisia',␣
↪'United Arab Emirates', 'Yemen']
arab_df = df[df['country_name'].isin(arab_countries)]

arab_avg = arab_df[[str(y) for y in range(2014, 2025)]].mean()

plt.plot(arab_avg.index, arab_avg.values, marker='o')
plt.title("Unemployment Trend in Arab Countries (Avg)")
plt.ylabel("Unemployment Rate (%)")
plt.xlabel("Year")
plt.grid(True)
plt.show()
```



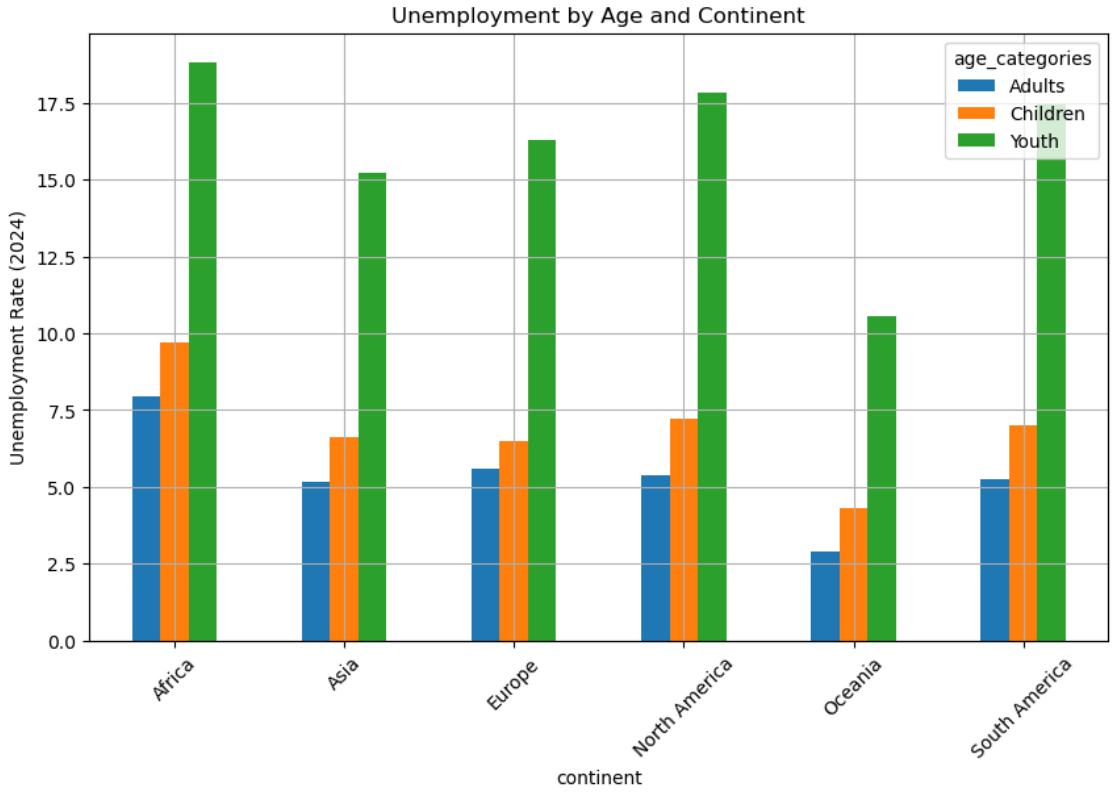
[205]:
```
#Gender differences were analyzed by continent.
gender_continent = df.groupby(['continent', 'sex'])['2024'].mean().unstack()
print(gender_continent)
gender_continent.plot(kind='bar', figsize=(10,6), title='Unemployment by Gender␣
↪and Continent (2024)')
plt.ylabel('Unemployment Rate')
plt.xticks(rotation=45)
plt.grid(True)
plt.show()
```

```
sex                Female       Male
continent
Africa          13.862800  10.453513
Asia            10.782204   7.208130
Europe           9.448906   9.470350
North America   11.233246   9.062614
Oceania          7.032583   4.828583
South America   11.642788   8.195303
```

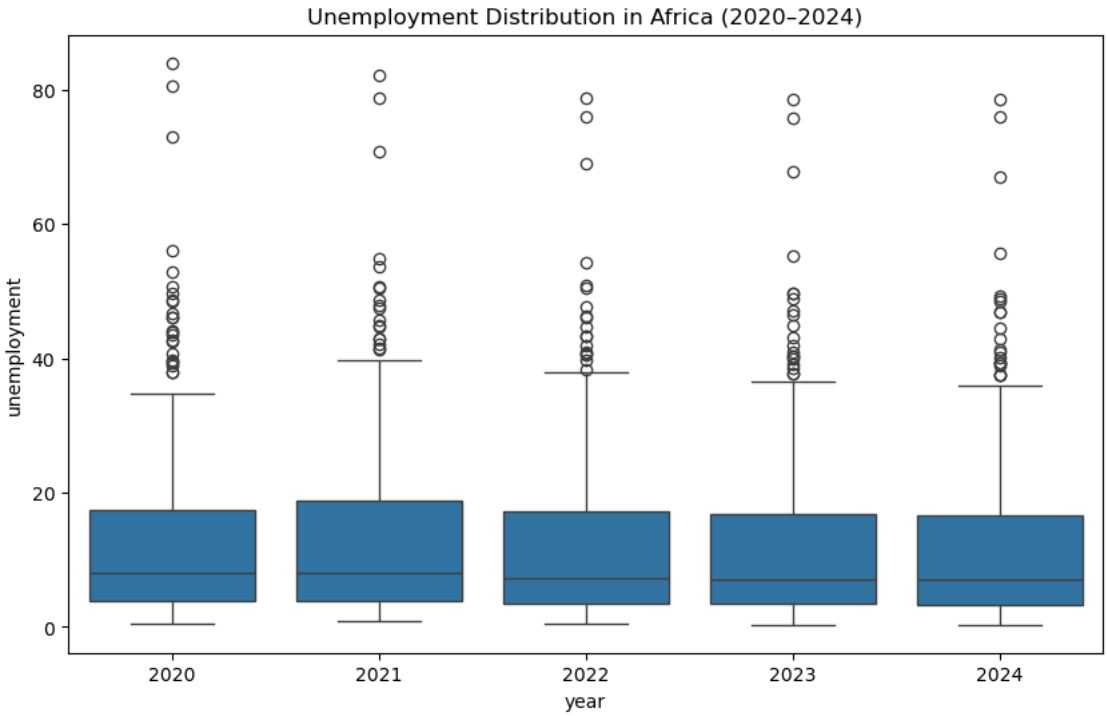


[201]:
```
#Age groups were compared across continents.
age_continent = df.groupby(['continent', 'age_categories'])['2024'].mean().
 ↪unstack()
print(age_continent)
age_continent.plot(kind='bar', figsize=(10,6), title='Unemployment by Age and␣
 ↪Continent')
plt.ylabel('Unemployment Rate (2024)')
plt.xticks(rotation=45)
plt.grid(True)
plt.show()
```

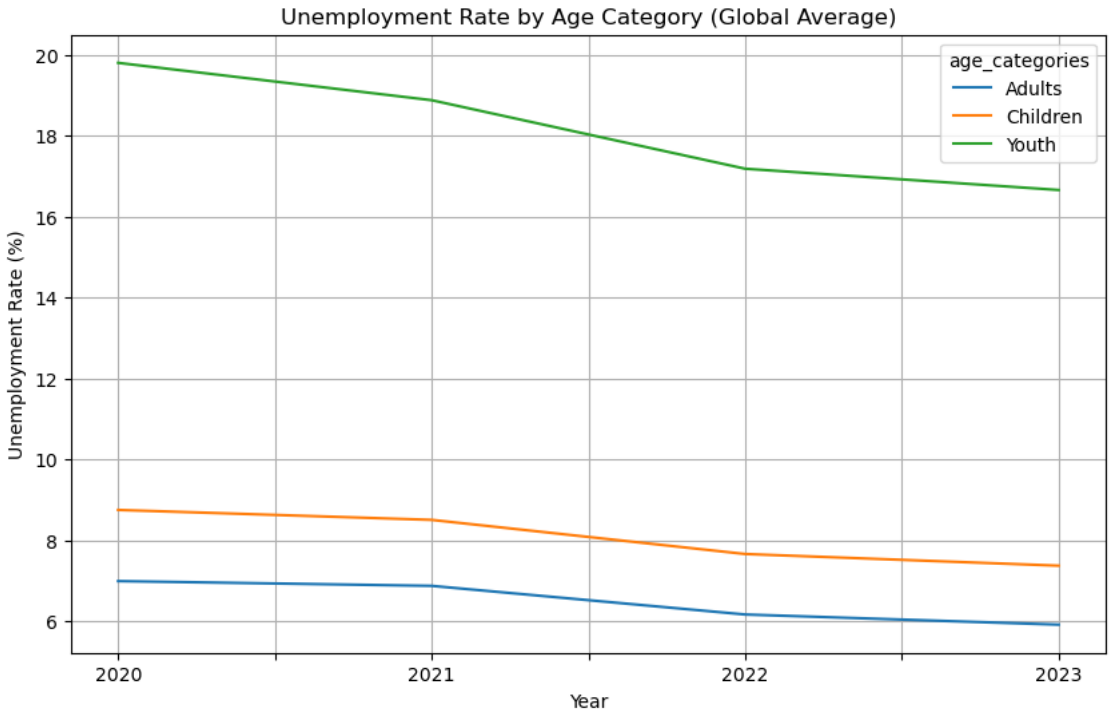
```
age_categories    Adults  Children      Youth
continent
Africa          7.943300  9.697760  18.833410
Asia            5.147000  6.617194  15.221306
Europe          5.596603  6.502795  16.279487
North America   5.388921  7.204447  17.850421
Oceania         2.898000  4.331125  10.562625
South America   5.267318  7.022318  17.467500
```



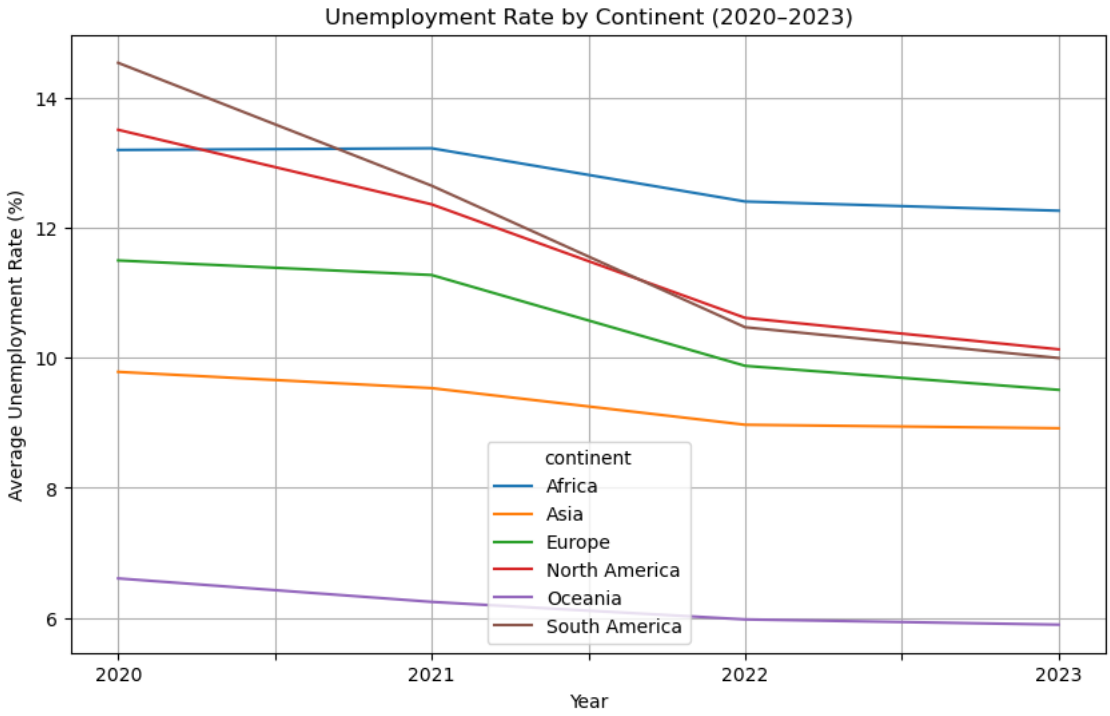
[165]:
```
africa_df = df[df['continent'] == 'Africa']

melted = africa_df.melt(id_vars=['country_name'], value_vars=[str(y) for y in␣
↪range(2020,2025)],
                        var_name='year', value_name='unemployment')

plt.figure(figsize=(10,6))
sns.boxplot(data=melted, x='year', y='unemployment')
plt.title("Unemployment Distribution in Africa (2020-2024)")
plt.show()
```



[171]:
```
# The average global unemployment rate for each age group is calculated over the␣
 ↪years
age_trends = df.groupby('age_categories')[years].mean().T
age_trends.plot(figsize=(10,6))
plt.title("Unemployment Rate by Age Category (Global Average)")
plt.xlabel("Year")
plt.ylabel("Unemployment Rate (%)")
plt.grid(True)
plt.show()
```

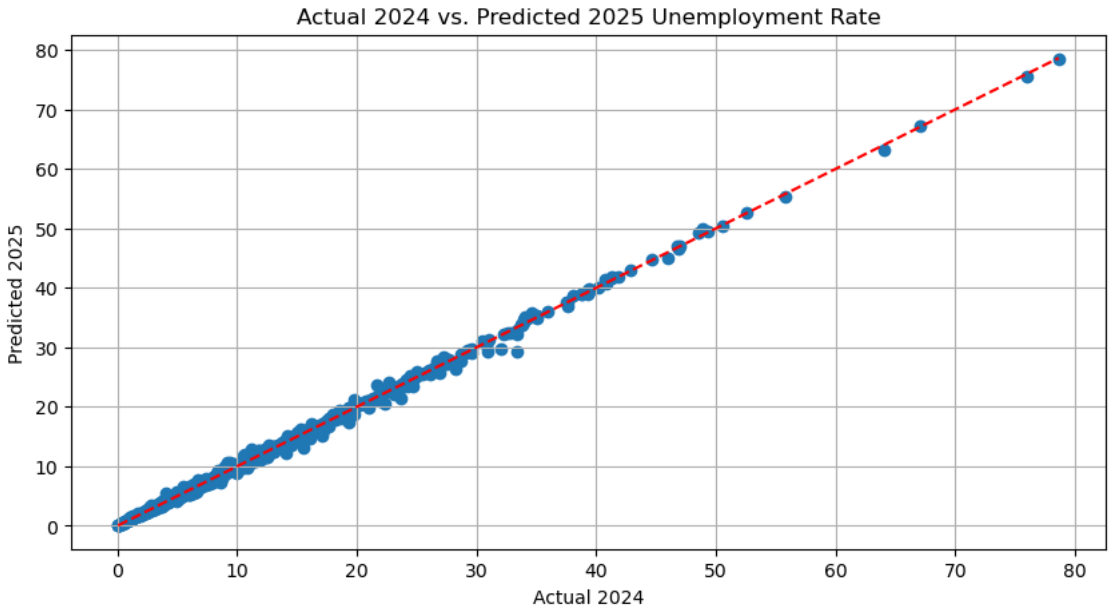


[219]:
```
# Unemployment rates are compared across different continents
years = [str(y) for y in range(2020, 2024)]
continent_avg = df.groupby('continent')[years].mean().T

continent_avg.plot(figsize=(10,6))
plt.title("Unemployment Rate by Continent (2020-2023)")
plt.xlabel("Year")
plt.ylabel("Average Unemployment Rate (%)")
plt.grid(True)
plt.show()
```



[231]:
```
# A detailed analysis of the prediction was conducted.
# An attempt was made to use LinearRegression, but a mismatch in data lengths␣
 ↪was encountered.

cols = ['2020', '2021', '2022', '2023', '2024']
data = df.dropna(subset=cols).copy()

X = data[['2020', '2021', '2022', '2023']]
y = data['2024']

model = LinearRegression()
model.fit(X, y)

# A safe prediction for the year 2025 was performed.
data.loc[:, '2025_pred'] = model.predict(X)
```

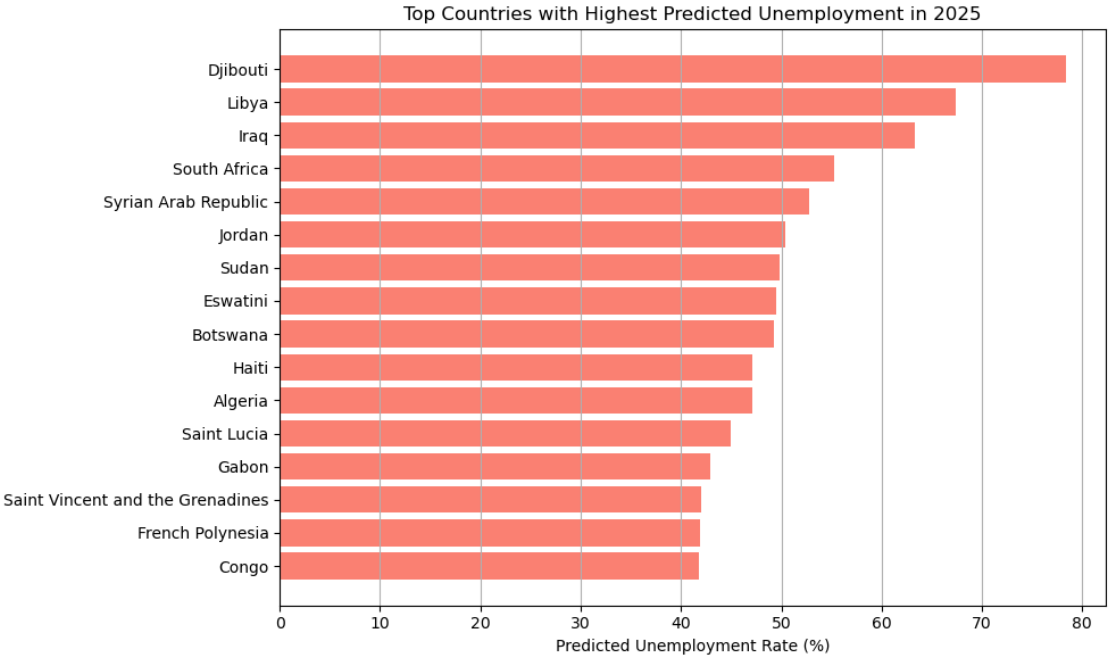
[235]:
```
# The differences between predicted and actual values were plotted.
plt.figure(figsize=(10,5))
plt.scatter(y, data['2025_pred'])
plt.plot([y.min(), y.max()], [y.min(), y.max()], 'r--')  #
plt.xlabel('Actual 2024')
plt.ylabel('Predicted 2025')
plt.title('Actual 2024 vs. Predicted 2025 Unemployment Rate')
plt.grid(True)
plt.show()
```



[263]:
```
top_predicted = data[['country_name', '2025_pred']].sort_values(by='2025_pred',␣
 ↪ascending=False).head(20)
print(top_predicted)


plt.figure(figsize=(10, 6))
plt.barh(top_predicted['country_name'], top_predicted['2025_pred'],␣
 ↪color='salmon')
plt.xlabel('Predicted Unemployment Rate (%)')
plt.title('Top Countries with Highest Predicted Unemployment in 2025')
plt.gca().invert_yaxis()
plt.grid(axis='x')
plt.tight_layout()
plt.show()
```

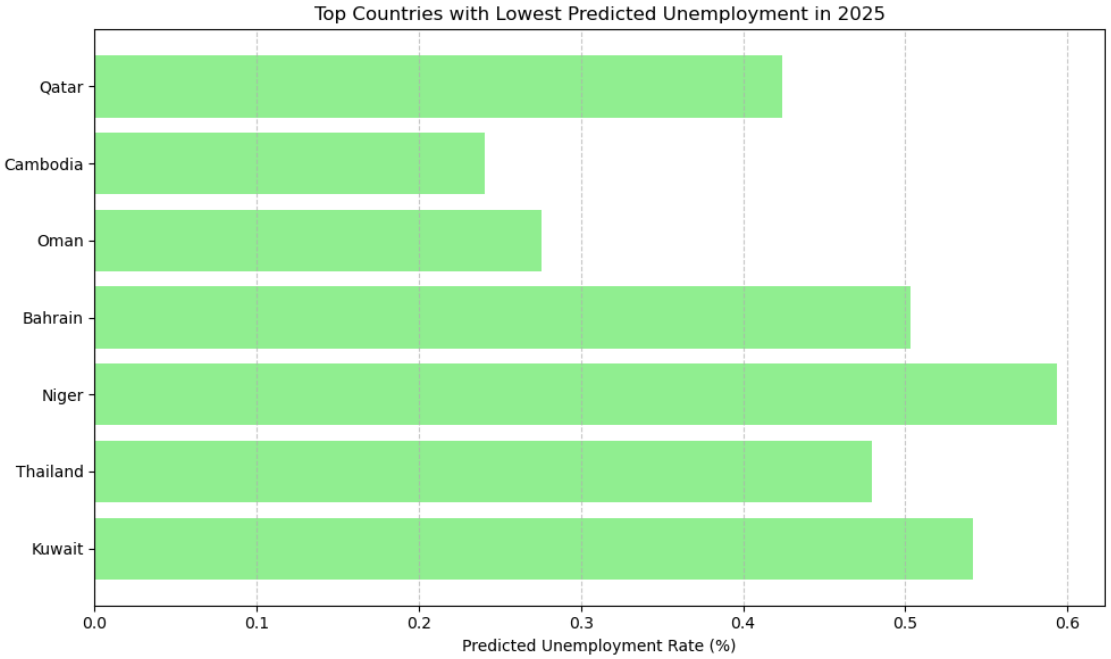
```
                    country_name  2025_pred
276                     Djibouti  78.421409
```

279	Djibouti	75.576690
582	Libya	67.350914
474	Iraq	63.305376
924	South Africa	55.292104
978	Syrian Arab Republic	52.740922
510	Jordan	50.397105
954	Sudan	49.848868
324	Eswatini	49.475333
120	Botswana	49.289815
426	Haiti	47.087481
12	Algeria	47.054067
927	South Africa	46.472492
849	Saint Lucia	44.906963
327	Eswatini	44.748594
360	Gabon	42.911133
855	Saint Vincent and the Grenadines	41.970456
354	French Polynesia	41.936769
225	Congo	41.748384
852	Saint Vincent and the Grenadines	41.403379



[261]:
```
# Top Countries with Lowest Predicted Unemployment in 2025
lowest_predicted = data[['country_name', '2025_pred']].
 ↪sort_values(by='2025_pred', ascending=True).head(20)

#
print("Top Countries with Lowest Predicted Unemployment in 2025:")
print(lowest_predicted)

plt.figure(figsize=(10, 6))
plt.barh(lowest_predicted['country_name'], lowest_predicted['2025_pred'],␣
 ↪color='lightgreen')
plt.xlabel('Predicted Unemployment Rate (%)')
plt.title('Top Countries with Lowest Predicted Unemployment in 2025')
plt.gca().invert_yaxis()
plt.grid(axis='x', linestyle='--', alpha=0.7)
plt.tight_layout()
plt.show()
```

```
Top Countries with Lowest Predicted Unemployment in 2025:
     country_name  2025_pred
826         Qatar   0.052432
827         Qatar   0.061129
166      Cambodia   0.090929
163      Cambodia   0.116043
167      Cambodia   0.182050
825         Qatar   0.206616
164      Cambodia   0.240405
766          Oman   0.275922
823         Qatar   0.280958
64        Bahrain   0.336531
732         Niger   0.385195
824         Qatar   0.424067
734         Niger   0.424805
1006     Thailand   0.439701
733         Niger   0.443492
1003     Thailand   0.479579
736         Niger   0.500131
65        Bahrain   0.503024
544        Kuwait   0.542017
737         Niger   0.593326
```


Top Countries with Lowest Predicted Unemployment in 2025
Qatar
Cambodia
Oman
Bahrain
Niger
Thailand
Kuwait
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Predicted Unemployment Rate (%)