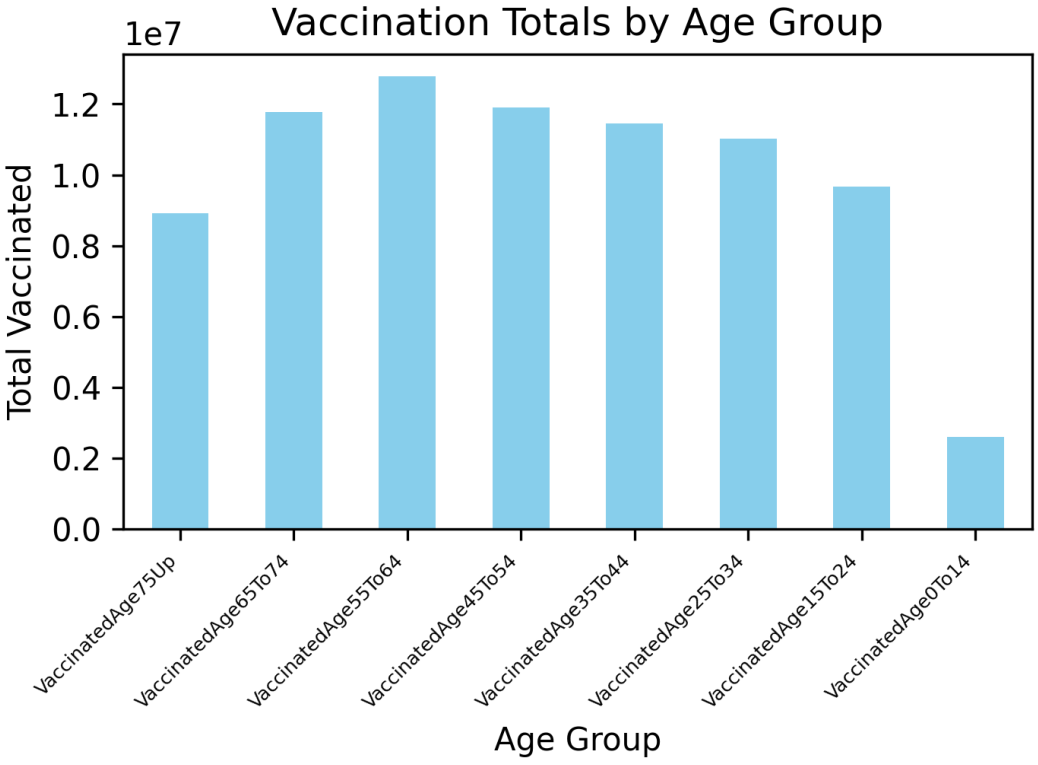
TASK 1: Build pretty plots.

A. Bar Chart.



This bar chart shows the total number of COVID-19 vaccinations administered by age group in Maricopa County.
The data highlights the variation in vaccination uptake across different age demographics.
Data source: Maricopa County Health Department.

Code used for building the bar plot.

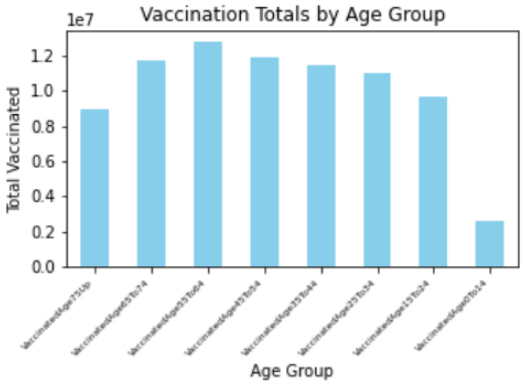
Build pretty plots

Question 1) How do the vaccination totals between age groups compare?

In [13]:
```
# Aggregate vaccination totals by age group
age_group_totals = {
    'VaccinatedAge75Up': df['VaccinatedAge75Up'].sum(),
    'VaccinatedAge65To74': df['VaccinatedAge65To74'].sum(),
    'VaccinatedAge55To64': df['VaccinatedAge55To64'].sum(),
    'VaccinatedAge45To54': df['VaccinatedAge45To54'].sum(),
    'VaccinatedAge35To44': df['VaccinatedAge35To44'].sum(),
    'VaccinatedAge25To34': df['VaccinatedAge25To34'].sum(),
    'VaccinatedAge15To24': df['VaccinatedAge15To24'].sum(),
    'VaccinatedAge0To14': df['VaccinatedAge0To14'].sum()
}

# Convert to DataFrame
age_group_totals_df = pd.DataFrame(list(age_group_totals.items()), columns=['Age
```

In [14]:
```
# Plot the bar chart
plt.figure(figsize=(12, 8))
age_group_totals_df.plot(kind='bar', x='Age Group', y='Total Vaccinated', color=

# Customize the plot
plt.title('Vaccination Totals by Age Group')
plt.xlabel('Age Group')
plt.ylabel('Total Vaccinated')
plt.xticks(rotation=45, ha='right', fontsize=6)  # Make x-labels smaller
plt.tight_layout(rect=[0, 0.1, 0.8, 1.0])  # Add space at the bottom for the cap


# Save the plot
plt.savefig('vaccination_totals_by_age_group_bar_chart.png', dpi=300)
plt.show()
```

```
<Figure size 864x576 with 0 Axes>
```

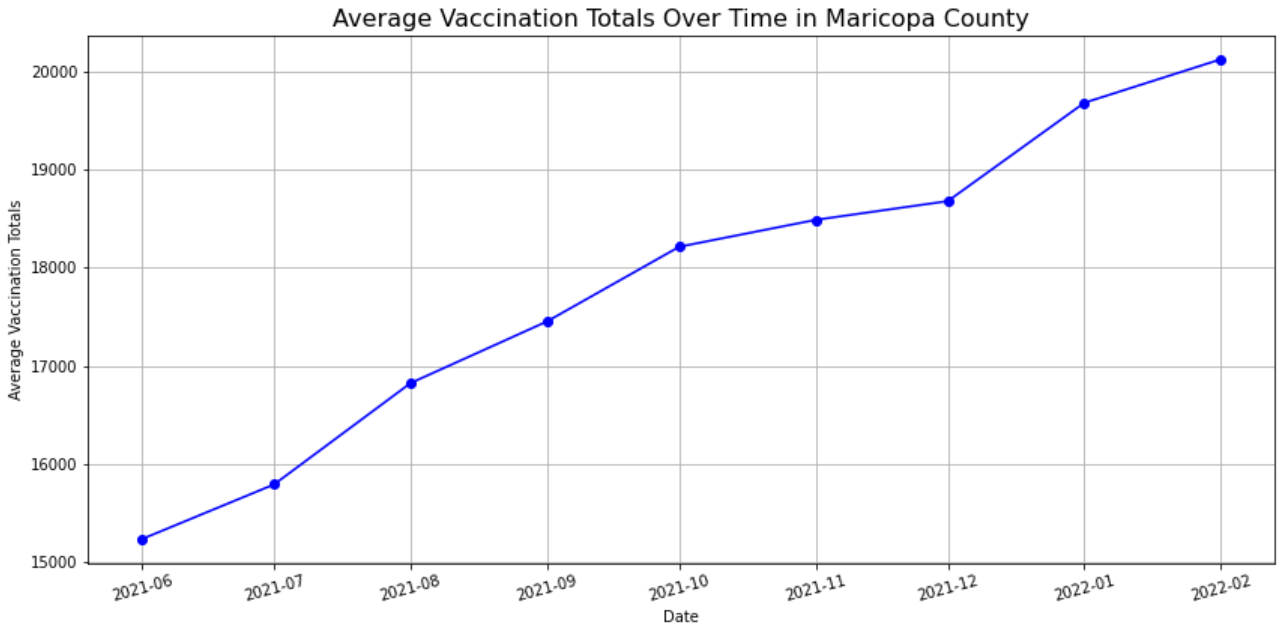


In [15]:

```python
from PIL import Image, ImageDraw, ImageFont

# Define the caption text
caption_text_unique = """
This bar chart shows the total number of COVID-19 vaccinations administered by a
The data highlights the variation in vaccination uptake across different age dem
Data source: Maricopa County Health Department.

"""

# Open the saved bar chart plot
bar_chart_image_path = "vaccination_totals_by_age_group_bar_chart.png"
bar_chart_image = Image.open(bar_chart_image_path)
draw_on_bar_chart = ImageDraw.Draw(bar_chart_image)

# Define the font and size
try:
    font = ImageFont.truetype("arial.ttf", 18)
except IOError:
    font = ImageFont.load_default()

# Define the position for the caption text
caption_position = (12, bar_chart_image.height - 90)  # Adjust as needed

# Add caption text to the image
draw_on_bar_chart.text(caption_position, caption_text_unique, fill="blue", font=

# Save the final image with caption
output_image_path = "vaccination_totals_with_caption.png"
bar_chart_image.save(output_image_path)

print(f"Caption added and image saved as {output_image_path}")
```

```
Caption added and image saved as vaccination_totals_with_caption.png
```

1. Line Plot.



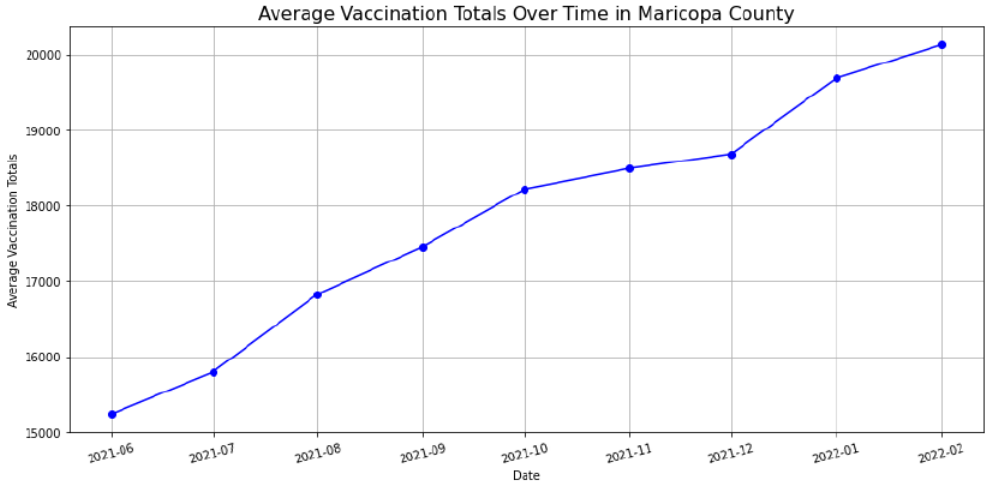
This line plot illustrates the average vaccination totals over time in Maricopa County.
The data is aggregated monthly to smooth out daily fluctuations.
The clear upward trend shows an increase in vaccination totals as efforts to vaccinate the population intensified.

Code used for building the Line plot.

Question 2) How have the average vaccination totals changed over time in Maricopa County?

In [16]:
```
# Aggregate the vaccination totals by date and calculate the average
df['TotalVaccinated'] = df[['VaccinatedAge75Up', 'VaccinatedAge65To74', 'Vaccina
                            'VaccinatedAge45To54', 'VaccinatedAge35To44', 'Vacci
                            'VaccinatedAge15To24', 'VaccinatedAge0To14']].sum(ax
average_vaccination_totals_df = df.groupby(df['CreateDate'].dt.to_period('M'))['
average_vaccination_totals_df['CreateDate'] = average_vaccination_totals_df['Cre
```

In [17]:
```
# Create the line plot

plt.figure(figsize=(12, 6))
plt.plot(average_vaccination_totals_df['CreateDate'], average_vaccination_totals

# Customize the plot
plt.title('Average Vaccination Totals Over Time in Maricopa County', fontsize=16
plt.xlabel('Date', fontsize=10)
plt.ylabel('Average Vaccination Totals', fontsize=10)
plt.grid(True)
plt.xticks(rotation=15)
plt.tight_layout()

# Save the plot
line_plot_filename_q2 = "average_vaccination_totals_over_time_line_plot.png"
plt.savefig(line_plot_filename_q2)
plt.show()
```

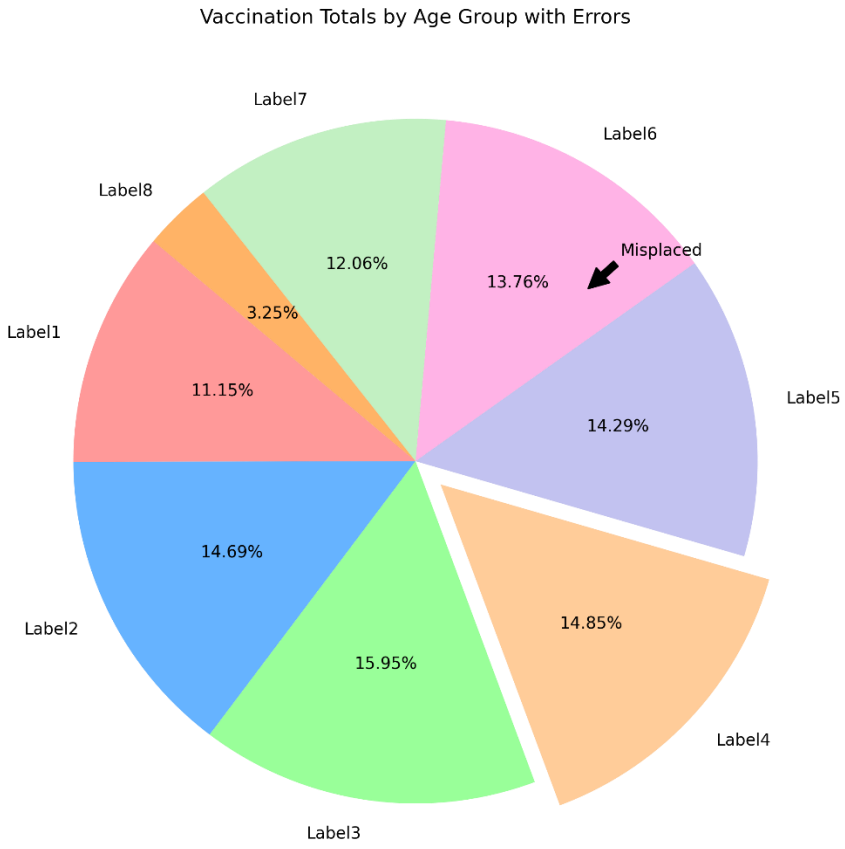


In [18]:

```
from PIL import ImageOps

# Open the saved plot
line_plot_image_q2 = Image.open(line_plot_filename_q2)

# Increase the canvas size to add space for the caption
extra_space = 100
line_plot_image_q2_with_border = ImageOps.expand(line_plot_image_q2, border=(0,

# Draw on the new image with extra space
draw_on_line_plot_q2 = ImageDraw.Draw(line_plot_image_q2_with_border)

# Define the caption
line_plot_caption_q2 = """
This line plot illustrates the average vaccination totals over time in Maricopa
The data is aggregated monthly to smooth out daily fluctuations.
The clear upward trend shows an increase in vaccination totals as efforts to vac
"""

# Define the font and size
try:
    line_plot_font_q2 = ImageFont.truetype("arial.ttf", 16)
except IOError:
    line_plot_font_q2 = ImageFont.load_default()

# Add caption text
caption_position_q2 = (10, line_plot_image_q2.height + 1)  # Adjust position acc
draw_on_line_plot_q2.text(caption_position_q2, line_plot_caption_q2, fill="black

# Save the final image with caption
final_line_plot_filename_q2 = "average_vaccination_totals_with_caption_q2.png"
line_plot_image_q2_with_border.save(final_line_plot_filename_q2)
```

Task 2: Build Ugly Plots.

1. Pie Chart.



This pie chart illustrates the total number of COVID-19 vaccinations administered by age group in Maricopa County.
The chart contains intentional errors including incorrect labels, inconsistent slice sizes, misleading colors, and poor contrast to demonstrate various pitfalls in data visualization.
Data source: Maricopa County Health Department.

Code used for building the pie chart.

Build Ugly plot

Question 1) How do the vaccination totals between age groups compare?

In [19]:
```
# Define the age groups and corresponding columns
unique_age_groups = [
    'VaccinatedAge75Up', 'VaccinatedAge65To74', 'VaccinatedAge55To64',
    'VaccinatedAge45To54', 'VaccinatedAge35To44', 'VaccinatedAge25To34',
    'VaccinatedAge15To24', 'VaccinatedAge0To14'
]

# Sum the vaccination totals for each age group
unique_age_totals = {
    age_group: df[age_group].sum() for age_group in unique_age_groups
}

# Convert to DataFrame
unique_age_totals_df = pd.DataFrame(list(unique_age_totals.items()), columns=['A
```

In [20]:

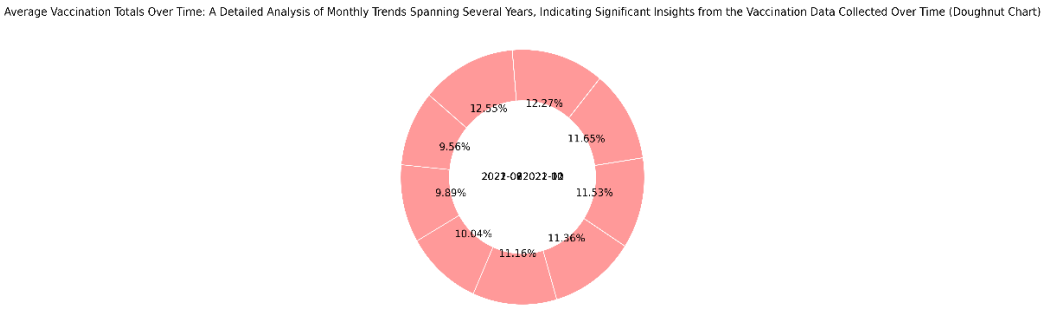
```
# Build the Pie Chart with Errors

# Data for the pie chart
error_labels = unique_age_totals_df['Age Group']
error_sizes = unique_age_totals_df['Total Vaccinated']

# Create the pie chart
plt.figure(figsize=(12, 8))

# Error 1. Incorrect labels or legends
incorrect_labels = ['Label1', 'Label2', 'Label3', 'Label4', 'Label5', 'Label6',

# Error 2. Overlapping slices
explode = (0, 0, 0, 0.1, 0, 0, 0, 0)  # Only one slice exploded

# Error 3. Misleading color choices
misleading_colors = ['#ff9999', '#66b3ff', '#99ff99', '#ffcc99', '#c2c2f0', '#ff

# Error 6. Inconsistent slice sizes
inconsistent_sizes = [size * 1.2 for size in error_sizes]  # Making sizes incons

# Error 7. Incorrect percentage formatting
incorrect_format = '%1.2f%%'

# Error 8. Poor color contrast
# Adjusted for visibility
adjusted_colors = ['#ff9999', '#66b3ff', '#99ff99', '#ffcc99', '#c2c2f0', '#ffb3

# Plot with all errors
plt.pie(inconsistent_sizes, labels=incorrect_labels, autopct=incorrect_format, s

# Error 9: Overlapping text
plt.annotate('Misplaced', xy=(0.5, 0.5), xytext=(0.6, 0.6),
             arrowprops=dict(facecolor='black', shrink=0.05))

# Add title (Error 4 handled here)
plt.title('Vaccination Totals by Age Group with Errors')
```

```
# Error 9: Overlapping text
plt.annotate('Misplaced', xy=(0.5, 0.5), xytext=(0.6, 0.6),
             arrowprops=dict(facecolor='black', shrink=0.05))

# Add title (Error 4 handled here)
plt.title('Vaccination Totals by Age Group with Errors')

# Adjust layout to accommodate the caption
plt.tight_layout(pad=2)

# Save the plot
pie_chart_filename_q1 = 'vaccination_totals_pie_chart_with_all_errors.png'
plt.savefig(pie_chart_filename_q1, dpi=300)

# Show the plot
plt.show()
```

In [21]:
```python
# Add Caption to the Pie Chart

# Define the caption text
pie_chart_caption_q1 = """
This pie chart illustrates the total number of COVID-19 vaccinations administere
The chart contains intentional errors including incorrect labels, inconsistent s
Data source: Maricopa County Health Department.
"""

# Open the saved pie chart plot
pie_chart_image_q1 = Image.open(pie_chart_filename_q1)
draw_on_pie_chart_q1 = ImageDraw.Draw(pie_chart_image_q1)

# Define the font and size
try:
    pie_chart_font_q1 = ImageFont.truetype("arial.ttf", 32)
except IOError:
    pie_chart_font_q1 = ImageFont.load_default()

# Define the position for the caption text
caption_position_q1 = (14, pie_chart_image_q1.height - 200)  # Adjust as needed

# Add caption text to the image
draw_on_pie_chart_q1.text(caption_position_q1, pie_chart_caption_q1, fill="black

# Save the final image with caption
final_pie_chart_filename_q1 = "vaccination_totals_with_caption_q1.png"
pie_chart_image_q1.save(final_pie_chart_filename_q1)

print(f"Caption added and image saved as {final_pie_chart_filename_q1}")
```

```
Caption added and image saved as vaccination_totals_with_caption_q1.png
```

2. Doughnut Chart



This doughnut chart illustrates the average vaccination totals by month. The chart highlights trends in vaccination rates over time, offering insights into the overall vaccination coverage across different months.

Code used for building the pie chart.

Question 2) How have the average vaccination totals changed over time in Maricopa County?

In [23]:
```
# Extract year and month for grouping
df['YearMonth'] = df['StartDate'].dt.to_period('M')

# Calculate average vaccination totals for each month
avg_vaccination_totals_by_month = df.groupby('YearMonth').mean(numeric_only=True

# Reset index to turn 'YearMonth' into a column
monthly_avg_vaccination_totals_df = avg_vaccination_totals_by_month.reset_index(
```

In [24]:

```
# Prepare data for plotting
doughnut_labels = monthly_avg_vaccination_totals_df['YearMonth'].astype(str).tol
doughnut_sizes = monthly_avg_vaccination_totals_df['TotalVaccinated'].tolist()

# Ensure lengths are consistent
num_slices = len(doughnut_sizes)
print(f"Number of slices: {num_slices}")

# Generate error parameters with correct length
doughnut_labels_with_errors = doughnut_labels[:num_slices]  # Truncate to match
doughnut_explode_with_errors = [0.01] * num_slices  # Minimal explode effect
doughnut_colors_poor_contrast = ['#ff9999'] * num_slices  # Poor contrast colors

# Debug lengths to ensure all parameters match
print(f"Length of labels_with_errors: {len(doughnut_labels_with_errors)}")
print(f"Length of explode_with_errors: {len(doughnut_explode_with_errors)}")
print(f"Length of colors_poor_contrast: {len(doughnut_colors_poor_contrast)}")

# Create the doughnut chart
fig, ax = plt.subplots(figsize=(12, 8))

# Create a doughnut chart by setting the width of the wedge (i.e., the 'width' o
wedges, texts, autotexts = ax.pie(doughnut_sizes,
                                  labels=doughnut_labels_with_errors,
                                  autopct='%1.2f%%',  # Incorrect percentage for
                                  startangle=140,
                                  explode=doughnut_explode_with_errors,
                                  colors=doughnut_colors_poor_contrast,
                                  wedgeprops=dict(width=0.4),  # Set width of th
                                  textprops=dict(size=15))  # Excessively large

# Overlap labels by setting positions manually
for text in texts:
    text.set_position((0, 0))

# Add title
plt.title('Average Vaccination Totals Over Time: A Detailed Analysis of Monthly
```

```
# Add title
plt.title('Average Vaccination Totals Over Time: A Detailed Analysis of Monthly

# Define the caption
doughnut_caption_text = (
    "This doughnut chart illustrates the average vaccination totals by month. Th
    "trends in vaccination rates over time, offering insights into the overall v
    "across different months."
)

# Add caption to the plot
fig.text(0.5, -0.1, doughnut_caption_text, ha='center', va='top', fontsize=20, b

# Adjust layout to accommodate the caption
plt.tight_layout(pad=5)

# Save the plot with caption
doughnut_chart_filename_q2 = 'average_vaccination_totals_doughnut_chart_with_cap
plt.savefig(doughnut_chart_filename_q2, dpi=300, bbox_inches='tight')

# Show the plot
plt.show()
```