Exercise Physiology & Homeostasis Lab Report

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1 Exercise Physiology & Homeostasis Lab Report

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1.1 Abstract

- In this lab we observed the vital signs of a person before, during, and after a cardio exercise.
- We then analyze the data and discuss the implications.

1.2 Results

1.2.1 Recording our sweat rate data

[ ]:
```
import pandas as pd

sweat_rate_data = [
        {
                "phase": "rest_pre_exercise",
                "dry_mass": .11,
                "wet_mass": .12,
                "mass_of_sweat": .1,
                "sweat_rate": .5
        },
        {
                "phase": "activity",
                "dry_mass": .11,
                "wet_mass": .13,
                "mass_of_sweat": .2,
                "sweat_rate": .6
        },
        {
                "phase": "rest_post_exercise",
                "dry_mass": .10,
                "wet_mass": .13,
                "mass_of_sweat": .3,
                "sweat_rate": 1.5
        }
]
```

```python
df_sweat_rate = pd.DataFrame(sweat_rate_data)

print(df_sweat_rate.to_markdown())
```

```
|    | phase              |   dry_mass |   wet_mass |   mass_of_sweat |
sweat_rate |
|---:|:-------------------|-----------:|-----------:|----------------:|---------
----:|
|  0 | rest_pre_exercise  |       0.11 |       0.12 |             0.1 |
0.5 |
|  1 | activity           |       0.11 |       0.13 |             0.2 |
0.6 |
|  2 | rest_post_exercise |       0.1  |       0.13 |             0.3 |
1.5 |
```

1.2.2 Recording our volunteer response data

[ ]:
```python
volunteer_data = [
        {
                "time": 4,
                "respiratory_rate": 24,
                "respiratory_volume": 3.5,
                "heart_rate": 78,
                "blood_pressure_systolic": 120,
                "blood_pressure_diastolic": 80,
                "phase": "rest_pre_exercise"
        },
        {
                "time": 8,
                "respiratory_rate": 25,
                "respiratory_volume": 3.5,
                "heart_rate": 80,
                "blood_pressure_systolic": 120,
                "blood_pressure_diastolic": 80,
                "phase": "rest_pre_exercise"
        },
        {
                "time": 12,
                "respiratory_rate": 26,
                "respiratory_volume": 4,
                "heart_rate": 76,
                "blood_pressure_systolic": 120,
                "blood_pressure_diastolic": 70,
                "phase": "rest_pre_exercise"
        },
```

```
    {
        "time": 16,
        "respiratory_rate": 30,
        "respiratory_volume": 3,
        "heart_rate": 110,
        "blood_pressure_systolic": 190,
        "blood_pressure_diastolic": 120,
        "phase": "exercise"
    },
    {
        "time": 20,
        "respiratory_rate": 34,
        "respiratory_volume": 3.2,
        "heart_rate": 90,
        "blood_pressure_systolic": 140,
        "blood_pressure_diastolic": 100,
        "phase": "exercise"
    },
    {
        "time": 24,
        "respiratory_rate": 20,
        "respiratory_volume": 3.7,
        "heart_rate": 114,
        "blood_pressure_systolic": 140,
        "blood_pressure_diastolic": 100,
        "phase": "exercise"
    },
    {
        "time": 28,
        "respiratory_rate": 20,
        "respiratory_volume": 3.7,
        "heart_rate": 110,
        "blood_pressure_systolic": 150,
        "blood_pressure_diastolic": 110,
        "phase": "exercise"
    },
    {
        "time": 32,
        "respiratory_rate": 26,
        "respiratory_volume": 3.7,
        "heart_rate": 94,
        "blood_pressure_systolic": 150,
        "blood_pressure_diastolic": 110,
        "phase": "exercise"
    },
    {
        "time": 36,
```

```
                "respiratory_rate": 18,
                "respiratory_volume": 3.7,
                "heart_rate": 94,
                "blood_pressure_systolic": 160,
                "blood_pressure_diastolic": 70,
                "phase": "rest_post_exercise"
        },
        {
                "time": 40,
                "respiratory_rate": 18,
                "respiratory_volume": 3.7,
                "heart_rate": 90,
                "blood_pressure_systolic": 170,
                "blood_pressure_diastolic": 80,
                "phase": "rest_post_exercise"
        },
        {
                "time": 40,
                "respiratory_rate": 18,
                "respiratory_volume": 3.7,
                "heart_rate": 84,
                "blood_pressure_systolic": 120,
                "blood_pressure_diastolic": 80,
                "phase": "rest_post_exercise"
        }
]

df_volunteer_data = pd.DataFrame(volunteer_data)

df_volunteer_data.style
```

[ ]: <pandas.io.formats.style.Styler at 0x7590be1cf950>

1.2.3 Tables

Sweat Rate Data (Table 12-2)

	dry_mass	wet_mass	mass_of_sweat	sweat_rate
rest_pre_exercise	0.11	0.12	0.1	0.5
activity	0.11	0.13	0.2	0.6
rest_post_exercise	0.1	0.13	0.3	1.5

Volunteer Response Data (Table 12-3)

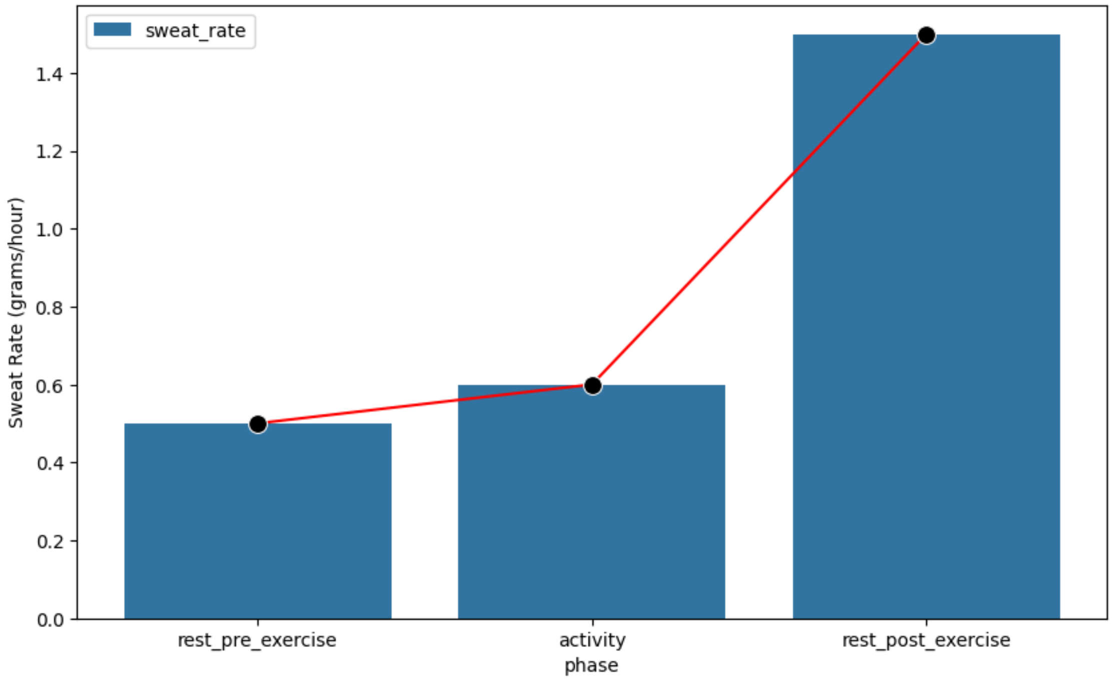
	time	respiratory rate	respiratory volume	heart rate	blood pressure systolic	blood pressure diastolic	phase
0	4	24	3.5	78	120	80	rest_pre_exercise
1	8	25	3.5	80	120	80	rest_pre_exercise
2	12	26	4	76	120	70	rest_pre_exercise
3	16	30	3	110	190	120	exercise
4	20	34	3.2	90	140	100	exercise
5	24	20	3.7	114	140	100	exercise
6	28	20	3.7	110	150	110	exercise
7	32	26	3.7	94	150	110	exercise
8	36	18	3.7	94	160	70	rest_post_exercise
9	40	18	3.7	90	170	80	rest_post_exercise
10	40	18	3.7	84	120	80	rest_post_exercise

1.2.4 Graphing the sweat rate data

- The sweat rate data shows a sharp increase when we reach the rest post exercise phase as well as a slight increase when we are in the exercise phase itself.

[ ]:
```
import seaborn as sns
import matplotlib.pyplot as plt
df_sweat_rate_only_sweat_rate = df_sweat_rate[['phase', 'sweat_rate']]
# Melt the DataFrame to a long format and rename the columns to better work␣
↪with graphs
df_sweat_rate_only_sweat_rate_melted = df_sweat_rate_only_sweat_rate.melt(
        id_vars='phase',
        var_name='measurement',
        value_name='value')

# Create the barplot
plt.figure(figsize=(10, 6))
sns.barplot(
        data=df_sweat_rate_only_sweat_rate_melted,
        x='phase',
        y='value',
        hue='measurement')
sns.lineplot(
        data=df_sweat_rate_only_sweat_rate_melted,
        x='phase',
        y='value',

        color='red',
        markers=True,
        marker='o',
        markersize=10,
        markerfacecolor='black')
```

```
plt.ylabel('Sweat Rate (grams/hour)')

plt.show()
```

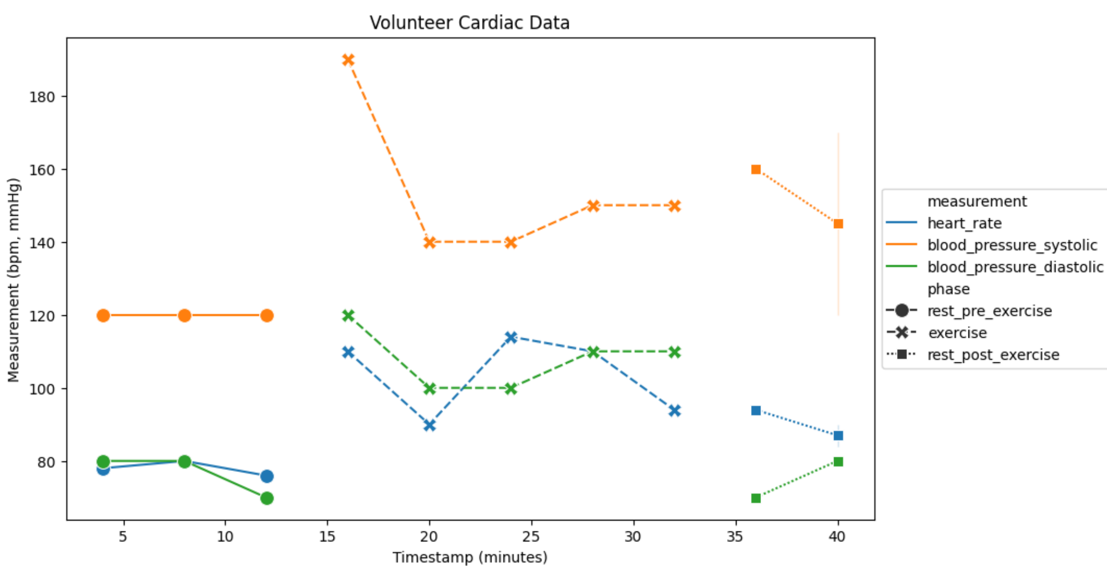


1.2.5 Graphing the cardiac variables

- In our cardiac variables we see a sharp jump in the values during the exercise phase and then during the rest phase it seems to gradually return to original values.

[ ]:
```
# Drop the respiratory rate and volume columns
df_volunteer_data_no_respiratory = df_volunteer_data.
 ↪drop(columns=['respiratory_rate', 'respiratory_volume'])

# Melt the DataFrame to a long format and rename the columns (for graphing)
df_volunteer_data_no_respiratory_melted = df_volunteer_data_no_respiratory.melt(
        id_vars=['time','phase'],
        var_name='measurement',
        value_name='value')


# Create the lineplot
plt.figure(figsize=(10, 6))
sns.lineplot(
        data=df_volunteer_data_no_respiratory_melted,
```

```
        x='time',
        y='value',
        hue='measurement',
        style='phase',
        markers=True,
        markersize=10,
        legend='full')

# Get the legend and make it outside of the plot
legend = plt.legend(loc='center left', bbox_to_anchor=(1, 0.5))

plt.xlabel('Timestamp (minutes)')

plt.ylabel('Measurement (bpm, mmHg)')

plt.title('Volunteer Cardiac Data')

plt.show()
```

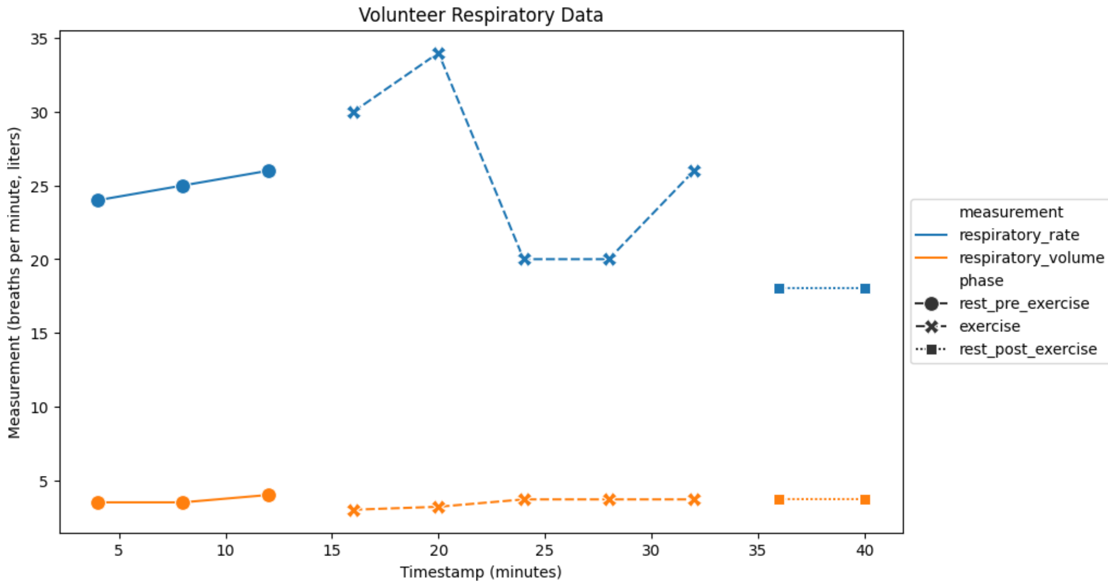


1.2.6 Graphing the respiratory variables

- In our respiratory data, the respiratory volume does not change significantly.
- The respiratory rate on the other hand sees a rather sharp jump at the start of the exercise phase and then slowly decreases towards the end.

[ ]:
```
# Now same thing but without the cardiac variables
df_volunteer_data_no_cardiac = df_volunteer_data.drop(
        columns=[
```

```python
                'heart_rate',
                'blood_pressure_systolic',
                'blood_pressure_diastolic'
        ]
)

df_volunteer_data_no_cardiac_melted = df_volunteer_data_no_cardiac.melt(
        id_vars=['time','phase'],
        var_name='measurement',
        value_name='value'
)

# Create the lineplot
plt.figure(figsize=(10, 6))
sns.lineplot(
        data=df_volunteer_data_no_cardiac_melted,
        x='time',
        y='value',
        hue='measurement',
        style='phase',
        markers=True,
        markersize=10,
        legend='full')

# Get the legend and make it outside of the plot
legend = plt.legend(loc='center left', bbox_to_anchor=(1, 0.5))

plt.title('Volunteer Respiratory Data')

plt.xlabel('Timestamp (minutes)')

plt.ylabel('Measurement (breaths per minute, liters)')

plt.show()
```



1.3 Discussion

1.3.1 Hypothesis

- The hypothesis, according to the lab manual, is that the human body continuously works to maintain a relatively stable internal state during a workout (Marion & Preszler, 2019).

1.3.2 Predicted vs Observed Results

- Our predicted results of the experiment were that we would see a significant increase in the rate of the body's vital processes such as sweating, cardiac variables, and respiratory variables when transitioning to the exercise phase then a decrease when transitioning out of the exercise phase.
- The observed results show a clear positive trend when the body goes from resting to exercising phases and then a negative trend when returning to resting phase. This is matching the predicted results except that the sweating continued to increase sharply when transitioning back to resting.

1.3.3 Conclusion

- From this test we can conclude that the hypothesis is supported by the results. This is because the trends and patterns we see in the measurements of respiratory and cardiac variables align with the idea that the body must continuously work to maintain a stable internal state. This is seen with an increase in values when we enter the exercise phase and then a decrease in most cases when we enter the resting post-workout phase.
- However, some small parts of the data seem to be anomalies or outliers. For example we see a very sharp jump in systolic blood pressure as soon as we enter the exercise phase before it returns to a much lower level.

- Our team did struggle when learning to use new tools and techniques for measuring body vitals and this could contribute to the outlier data.
- Further testing with revised processes could provide more robust results.

1.4 References

Marion, A. L., & Preszler, R. W. (2019). Biology 101 Human Biology & Society Laboratory Manual (9th ed., Vols. 1–9). Harden-McNeil.