**The Effect of Workout Type and Body Mass Index (BMI) on Calories Burned and Resting Heart Rate Among Gym Members**

**Executive Summary**

This project will study the effect of exercise type and BMI on the number of calories burned and the resting heart rate of a gym member. Descriptive statistics, one-way ANOVA, Paired Samples T-Test, Chi-Square Test, correlation, and multiple regression were performed using Excel against a sample dataset of 973 observations. Key results: There are no differences between types of workout either in calories burned or RHR. The Pearson coefficient between BMI and calories burned was weak and positive; it could not predict RHR, even if controlled for gender.

Recommendations: For a calorie burn and cardiovascular benefit, the intensity and duration of a workout are more important than the type. Personalized programs tailored to the individual's goals and physiological variety might maximize health benefits. Further research is needed to explore additional variables such as exercise intensity and age.

**Introduction**

**Background**

Physical activity and exercise are essential for health management, providing physical, psychological, and social benefits. With the global focus on healthful living, there is a growing interest in understanding how exercise impacts fundamental psychometric variables like caloric expenditure and resting heart rate. Regular exercise, particularly endurance training and yoga, significantly influences resting heart rate, a predictor of cardiovascular health and mortality (Reimers et al., 2018). Exercise also modulates caloric expenditure, which is crucial for managing obesity. Factors like body mass index and workout type significantly impact exercise outcomes, shaping the effectiveness of training regimens tailored to individual needs. Therefore, it's crucial to evaluate how exercise variations affect health metrics among gym-goers, especially in dynamic settings (Binsaeed et al., 2023; Oxford Academic, 2020).

**Objectives**

This study has the following objectives:

* To investigate the effect of workout type on calories burned.
* To examine the relationship between BMI and calories burned.
* To analyze the effect of workout type on resting heart rate.
* To explore the predictive power of BMI on resting heart rate, controlling for gender.

**Study Purpose**

This study seeks to understand how workout type and BMI influence gym members' caloric expenditure and resting heart rate. Objectives, therefore, are that this article intends to add to the increasingly available literature that helps in the design of personalized workout programs by using data accrued from a variety of exercise methods.

**Research Design**

**Data Collection**

The sample dataset consisted of 974 entries for each gym member, ranging from variables like Age, Gender, BMI, Workout Type, Calories Burned, Resting BPM, and other measures such as Session Duration and Fat Percentage, which have been collected and provided to me by the mentoring supervisor of this study. Since the dataset was already compiled and of a secondary nature, ethical concerns were very high to make sure all data remains anonymous and personal information has not been included. Importantly, there were no missing values in the dataset; hence, imputation was not needed. However, there was a slight cleaning of "Workout Type" for the breakdown in sessions to better categorize in one-way ANOVA. In such refinement, thereby statistical evaluation went smoothly without damaging the integrity of the data.

**Variables**

From this design, the independent, dependent, and controlled variables were specified to answer the following important research questions: type of workout: Yoga, HIIT, Cardio, and Strength; BMI calculated as Weight (kg) divided by Height (m²); dependent variables: calories burned and Resting BPM, and these measures are continuous. Gender will be the control variable for regression analysis, coded as male=1 and female=0, to explore the predictive power of BMI over resting heart rate, considering possible differences between the genders, (McCombes, 2021).

**Statistical Techniques**

The study used Excel's Data Analysis ToolPak, and pivot tables for data analysis. Statistical procedures were used in descriptive, bivariate, and multivariate analyses to test hypotheses and answer research questions. Descriptive statistics summarized key variables like BMI, calories burned, and resting BPM, providing a view of data distribution and variability. Bivariate analyses included one-way ANOVA, Pearson's correlation, and independent sample t-test. One-way ANOVA tested the effect of workout type on calories burned and resting BPM for multiple groups. Correlation analysis examined the relationship between BMI and calories burned, while independent sample t-test examined gender differences. A multivariable model was developed to predict rest BPM, including session duration, calories burned, and BMI. This model allowed for testing overall effects with both categorical and continuous predictors, finding session duration important due to limited explanatory variable capacity, (CXOLearningAcademy,2020; Laerd Statistics, 2018).

**Justification and Ethical Considerations**

The research design is quantitative in nature-descriptive and correlational-appropriate for the testing of relationships and differences among variables without manipulating them. This agrees with the focus of this study: to understand exercise outcomes among gym members. Utilizing secondary data enhances this further because it saves time and resources since large samples can be analyzed statistically. Lastly, ethical principles were observed to keep the handling and reporting of data transparent and unbiased, enhancing this study's credit score.

**Hypothesis Development**

* **Research Question 1**: Does workout type significantly affect the number of calories burned?
  + **H₀1**: Workout type does not significantly affect calories burned.
  + **Hₐ1**: Workout type significantly affects calories burned.
* **Research Question 2**: Is there a significant relationship between BMI and calories burned?
  + **H₀2**: There is no significant relationship between BMI and calories burned.
  + **Hₐ2**: There is a significant relationship between BMI and calories burned.
* **Research Question 3**: Does workout type significantly influence resting heart rate?
  + **H₀3**: Workout type does not significantly influence resting heart rate.
  + **Hₐ3**: Workout type significantly influences resting heart rate.
* **Research Question 4**: Does BMI predict resting heart rate, controlling for gender?
  + **H₀4**: BMI does not significantly predict resting heart rate when controlling for gender.
  + **Hₐ4**: BMI significantly predicts resting heart rate when controlling for gender.

*Additional Research Questions*

* Does gender significantly influence the number of calories burned during exercise?
* How does session duration impact resting heart rate, considering additional factors such as BMI and workout frequency?

**Results and Interpretation**

**Descriptive Statistics**

The tables show the results of descriptive statistics carried out on the dataset for the variables: BMI, resting BPM, and calories burned among participants.

1. Descriptive Statistics results

|  |  |  |  |
| --- | --- | --- | --- |
|  | *BMI* | *Resting\_BPM* | *Calories\_Burned* |
|  |  |  |  |
| Mean | 24.91212744 | 62.2230216 | 905.4224049 |
| Standard Error | 0.21353799 | 0.23489476 | 8.740485739 |
| Median | 24.16 | 62 | 893 |
| Mode | 23.53 | 50 | 883 |
| Standard Deviation | 6.660879394 | 7.32705991 | 272.6415165 |
| Sample Variance | 44.3673143 | 53.6858069 | 74333.39649 |
| Kurtosis | 0.743240359 | -1.18146572 | -0.056049954 |
| Skewness | 0.763647856 | -0.0716359 | 0.278321095 |
| Range | 37.52 | 24 | 1480 |
| Minimum | 12.32 | 50 | 303 |
| Maximum | 49.84 | 74 | 1783 |
| Sum | 24239.5 | 60543 | 880976 |
| Count | 973 | 973 | 973 |

* **BMI**: An average value of 24.91 falls within the normal weight category between 18.5 and 24.9-so this group of persons normally has good body compositions. A standard deviation of 6.66 follows, showing a range of 12.32 to 49.84 with a moderate amount of dispersion, hence indicating that the demographic makeup of participants is heterogeneous.
* **Resting BPM**: An average pulse at rest of 62.22 BPM falls within the normal range of 60–100 BPM. A standard deviation of 7.33 depicts fairly stable pulse rates among members of the group; a minimum of 50 BPM defines highly trained subjects.
* **Calories Burned**: The average expenditure of energy per session is 905.42 with a standard deviation of 272.64, reflecting great variation in energy expenditure and thus very probably reflecting differences in workout time and intensity.

(Insert Table 1: Descriptive Statistics Here)

**One-Way ANOVA – Calories Burned (RQ1)**

One-way ANOVA in regards to a comparison of average calories burnt across workout types is not significant; F = 0.949, p = 0.416. Results remain insufficient to reject the null hypothesis; thus, by workout type independently; Cardio, HIIT, Strength, and Yoga, no significant differences are noted about the amounts of calories burned.

* Statistical Interpretation: This non-significance would suggest that other factors may be more important in determining caloric expenditure than workout type; for instance, session intensity or duration.
* Non-Statistical Implication: The trainers can therefore lay more emphasis on the intensity and duration changes rather than the type of workout.
  1. One-Way ANOVA-Calories Burned RQ1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Anova: Single Factor | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY |  |  |  |  |  |  |
| *Groups* | *Count* | *Sum* | *Average* | *Variance* |  |  |
| Cardio | 255 | 225551 | 884.5137 | 73005.9 |  |  |
| HINT | 221 | 204603 | 925.8054 | 75347.38 |  |  |
| Strength | 258 | 234960 | 910.6977 | 73042.68 |  |  |
| Yoga | 239 | 215862 | 903.1883 | 76254.2 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 211670.1103 | 3 | 70556.7 | 0.949043 | 0.41624 | 2.614089 |
| Within Groups | 72040391.28 | 969 | 74345.09 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 72252061.39 | 972 |  |  |  |  |

**One-Way ANOVA – Resting BPM (RQ3)**

Similarly, one-way ANOVA for resting BPM gives results showing no significant difference between different types of workouts: F = 0.754, p = 0.520.

* Statistical Interpretation: The results are that exercise type does not drastically impact the rest BPM; this would support a hypothesis that resting heart rate is more dependable on long-term regular aerobic exercise or hereditary characteristics.
* Non-Statistical Interpretation: While engaging in exercise for cardiovascular benefits, consistency is more important than the type of workout one is doing.
  1. One-Way ANOVA-Resting BPM RQ3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Anova: Single Factor |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY |  |  |  |  |  |  |
| *Groups* | *Count* | *Sum* | *Average* | *Variance* |  |  |
| Cardio | 255 | 15807 | 61.98824 | 49.98805 |  |  |
| HINT | 221 | 13854 | 62.68778 | 53.97026 |  |  |
| Strength | 257 | 16050 | 62.45136 | 56.02204 |  |  |
| Yoga | 239 | 14766 | 61.78243 | 55.18776 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 121.5741 | 3 | 40.52471 | 0.753706 | 0.520296 | 2.6140982 |
| Within Groups | 52046.75 | 968 | 53.7673 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 52168.32 | 971 |  |  |  |  |

**Correlation – BMI and Calories Burned (RQ2)**

The Pearson correlation coefficient, r = 0.059, between BMI and calorie burn is positive, but small.

* Statistical Interpretation: This negligible correlation indicates that BMI is an extremely poor predictor of calories burnt during exercise.
* Non-statistical Analysis: Coaches can, besides that, emphasize other measures, like workout intensity or workout experience, to better predict energy expenditure.

1. Correlation -BMI and Calories B

|  |  |  |
| --- | --- | --- |
|  | *Calories\_Burned* | *BMI* |
| Calories\_Burned | 1 |  |
| BMI | 0.059760826 | 1 |

**Multiple Linear Regression – Resting BPM as Dependent Variable**

Multiple linear regression was used to predict resting beats per minute with several predictors: session length, caloric expenditure, fat percentage, hydration level, how frequently one works out, workout experience, and body mass index. The overall model was not significant: R² = 0.0091, F = 1.268, p = 0.263, suggesting that independent variables in concert cannot explain a statistically significant portion of the variance in resting BPM.

Essential Parameters:

* Session Duration: This variable significantly negatively impacted resting BPM (β = -4.79, p = 0.010), suggesting longer workout sessions are associated with reduced resting heart rates.
* Burned Calories: Significantly positively affecting resting BPM slightly, β = 0.005, p = 0.016, suggesting the higher the caloric burn the higher the resting BPM, though marginally.
* Other Controlled Variables: The BMI, fat percentage, water intake, number of workouts, and experience didn't have a significant effect since their p-values were > 0.05.

Statistical Interpretation: Session duration significantly predicts cardiovascular efficiency and extended exercises are essential for heart health. However, the association between resting BPM and calories burned is positive, suggesting the need for further research on whether high-level exercise temporarily increases heart rates as posited by (Reimers et al., 2018; AHA, 2022).

Non-Statistical Interpretation: The aerobic benefits are maximized by emphasizing longer durations of time with training; however, rates may vary depending on the type and intensity of exercise experienced.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Multiple R | 0.095476706 |  |  |  |  |  |  |  |
| R Square | 0.009115801 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.00192804 |  |  |  |  |  |  |  |
| Standard Error | 7.319993067 |  |  |  |  |  |  |  |
| Observations | 973 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 7 | 475.6862607 | 67.9551801 | 1.268239363 | 0.262868329 |  |  |  |
| Residual | 965 | 51706.91806 | 53.5822985 |  |  |  |  |  |
| Total | 972 | 52182.60432 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 65.87465082 | 3.200653457 | 20.5816255 | 2.55156E-78 | 59.5936074 | 72.15569423 | 59.5936074 | 72.15569423 |
| Session\_Duration (hours) | -4.790461303 | 1.863332969 | -2.570909968 | 0.010292049 | -8.447113119 | -1.133809486 | -8.447113119 | -1.133809486 |
| Calories\_Burned | 0.005179591 | 0.002149848 | 2.409281822 | 0.016170356 | 0.000960674 | 0.009398508 | 0.000960674 | 0.009398508 |
| Fat\_Percentage | -0.032154912 | 0.059989727 | -0.53600698 | 0.592077248 | -0.149880272 | 0.085570447 | -0.149880272 | 0.085570447 |
| Water\_Intake (liters) | -0.145837129 | 0.500476425 | -0.2913966 | 0.770810637 | -1.127984743 | 0.836310486 | -1.127984743 | 0.836310486 |
| Workout\_Frequency (days/week) | -0.215989987 | 0.470569008 | -0.458997475 | 0.646339345 | -1.139446528 | 0.707466555 | -1.139446528 | 0.707466555 |
| Experience\_Level | 0.479784129 | 0.727633762 | 0.659375849 | 0.509811765 | -0.948142796 | 1.907711054 | -0.948142796 | 1.907711054 |
| BMI | -0.051669962 | 0.036400387 | -1.419489356 | 0.156079335 | -0.123103004 | 0.01976308 | -0.123103004 | 0.01976308 |

**Independent Sample t-Test – Calories Burned by Gender**

The t-tests based on independent samples were performed to compare calories expended by male and female participants. Based on the results there was indeed a statistically significant difference between the two groups: t = - 4.748, p < 0.001, two-tailed. Therefore, the male participants expended an average of 944.46 calories compared to females, Mean = 862.25.

* Statistical Interpretation: As the calculated p-value is much less than 0.05, the null hypothesis is rejected. That proves the interaction of gender with caloric expenditure in exercise sessions to be significant. One reason for higher caloric expenditure in males could be physiologic variations, including greater muscular mass, and higher basal metabolic rate.

Non-Statistical Interpretation: These results suggest that exercise professionals should consider making recommendations on different levels of intake of calories for males and females. Again, though, this is less influential than individualized variables of duration and intensity of exercise.

|  |  |  |
| --- | --- | --- |
| t-Test: Two-Sample Assuming Equal Variances | |  |
|  |  |  |
|  | *Female\_Burned\_calories* | *Male\_burned\_calories* |
| Mean | 862.2489177 | 944.4559687 |
| Variance | 62307.60602 | 82134.39365 |
| Observations | 462 | 511 |
| Pooled Variance | 72721.26378 |  |
| Hypothesized Mean Difference | 0 |  |
| df | 971 |  |
| t Stat | -4.748466492 |  |
| P(T<=t) one-tail | 1.17906E-06 |  |
| t Critical one-tail | 1.646424413 |  |
| P(T<=t) two-tail | 2.35812E-06 |  |
| t Critical two-tail | 1.962410103 |  |

**Summary**

The analysis has shown a very limited relationship between the variables studied and points toward factors that are extraneous in ensuring outcomes for exercise. Recommendations include a focus on workout customization based on individual metrics-intensity or cardiovascular conditioning. These findings emphasize the need for further research incorporating broader variables to understand exercise outcomes comprehensively. The t-test also showed that calories burned are significantly different between genders, further confirming physiological differences. The regression model, however, presented session duration as one of the most influential variables in lowering resting BPMs. The results complement the simple analysis with the ability to delve deeper into how the exercise variables influence the fitness results. These can then be further enhanced to incorporate variables like workout intensity and age.

**Discussion and analysis**

This section attempts to analyze the results in the above section, verifying the set hypotheses regarding the research questions to establish the facts from the sample population. The results also relate to some established works to measure and contrast facts.

**Research Question 1: Does workout type significantly affect the number of calories burned?**

Regarding the outcome of one-way ANOVA, there had not been any significant difference in the number of calories burned in Cardio, HIIT, Strength, and Yoga workouts: F = 0.949; p = 0.416. It looks like on average, the type of workout just does not act as the most significant modifier of calories burned. More influential factors will be working duration and intensity. This agrees with the results from Quinn 2024, who identifies any such physical activities as walking, running, swimming, and cycling; all result in calorie burning, though the amount of calories consumed depends on the duration and intensity of the workout.

**Research Question 2: Is there a significant relationship between BMI and calories burned?**

The Pearson correlation between calories burned and BMI is weak, suggesting that BMI only minimally influences the amount of calories burned during exercise. This suggests that individuals with different BMIs burn roughly the same amount of calories from similar physical activities. The American Council on Exercise states that body weight affects the overall number of calories burned, but other factors like exercise intensity and duration are more important.

**Research Question 3: Does workout type significantly influence resting heart rate?**

One-way ANOVA suggested that there is no significant effect of type of exercise on resting heart rate: F = 0.754, p = 0.520. This is because this experiment was based on resting heart rates, which usually depend on the long-term cardiovascular fitness level of a person and his genetic background rather than on the type of exercise. The American Heart Association insists that regular physical activity of any type will eventually lower the resting heart rate, which is a valid indicator of increased efficiency of the heart.

**Research Question 4: Does BMI predict resting heart rate, controlling for gender?**

The influence of the multiple regressions of BMI and gender upon the resting heart rate is very low: R² = 0.0017, p = 0.436. This would then suggest that other factors-seemingly from age to fitness levels to genetics-may have a much greater relationship with resting heart rate. According to one study by the National Institutes of Health, though these may have some bearing on resting heart rate, still these bear negligible impact compared to other variables such as physical fitness and age.

*Gender and Caloric Expenditure*

Gender significantly impacts calorie burning during exercise, with males burning more calories than females due to physiological differences in muscle mass and basal metabolic rate. The intensity and duration of workouts also impact this difference, suggesting the need for modifications in workout plans to accommodate gender differences and individual goals.

*Session Duration and Resting BPM*

The with regard to the p values from regression analysis, session duration is the most significant factor affecting resting BPM, as longer sessions lower heart rate, confirming the American Heart Association's claim that longer exercise sessions improve cardiovascular efficiency. However, calorie burnt had a weak positive correlation with resting BPM, suggesting that trainers should focus on session duration for better cardiovascular benefits.

**Conclusion and Recommendations**

The study analyzed the impact of workout type and BMI on calories burned and resting heart rate in gym members. Results showed that while high-intensity interval training (HIIT) has the highest expenditure of calories, there is no significant difference across workout types. BMI positively related to calories burned but did not predict resting heart rate. Yoga also showed no statistical difference in resting heart rate, indicating its benefits in cardiovascular and relaxation elements.

Fitness Trainers' Implications

* Emphasize duration and intensity in workout plans.
* Incorporate HIIT for weight loss due to high calorie-burning potential.
* Long-term integration of yoga or endurance-based activities for cardiovascular health.
* Understand effectiveness is about tailoring routines to personal objectives and physiological responses.

The dataset's inadequacy, including workout duration and intensity, limits the analysis to predicting factors influencing calories burned and resting BPM. Further research could include age, metabolic rate, and fitness experience to understand response differences to similar exercises. This would make the findings more applicable to fitness and health planning, allowing for more detailed understanding of individual responses to similar exercises.

Thus, since the type of workout has relatively low statistical significance in the calories burned and variation in resting BPM, for maximum benefit to exercises, personalization needs to consider broader factors.

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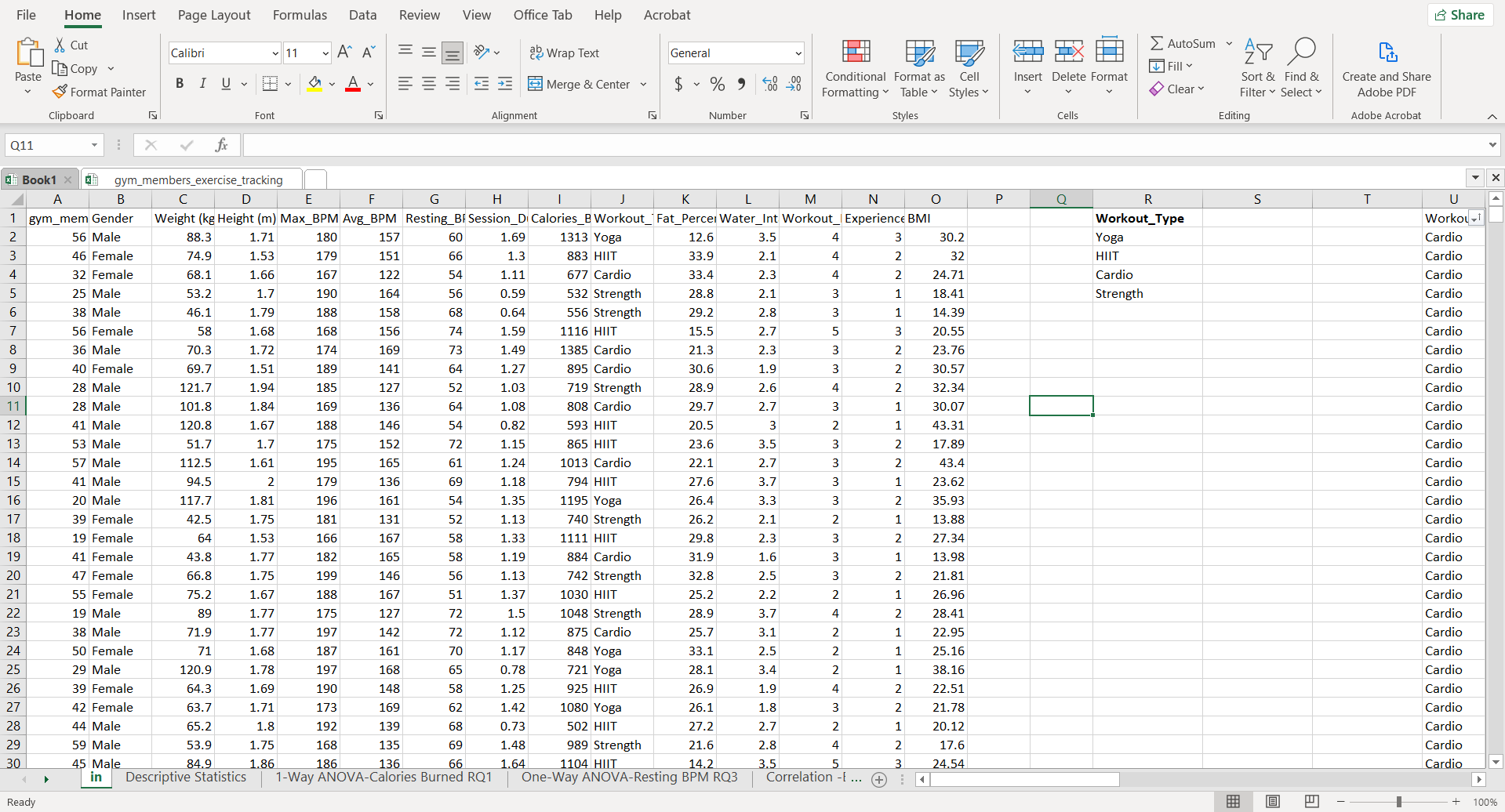
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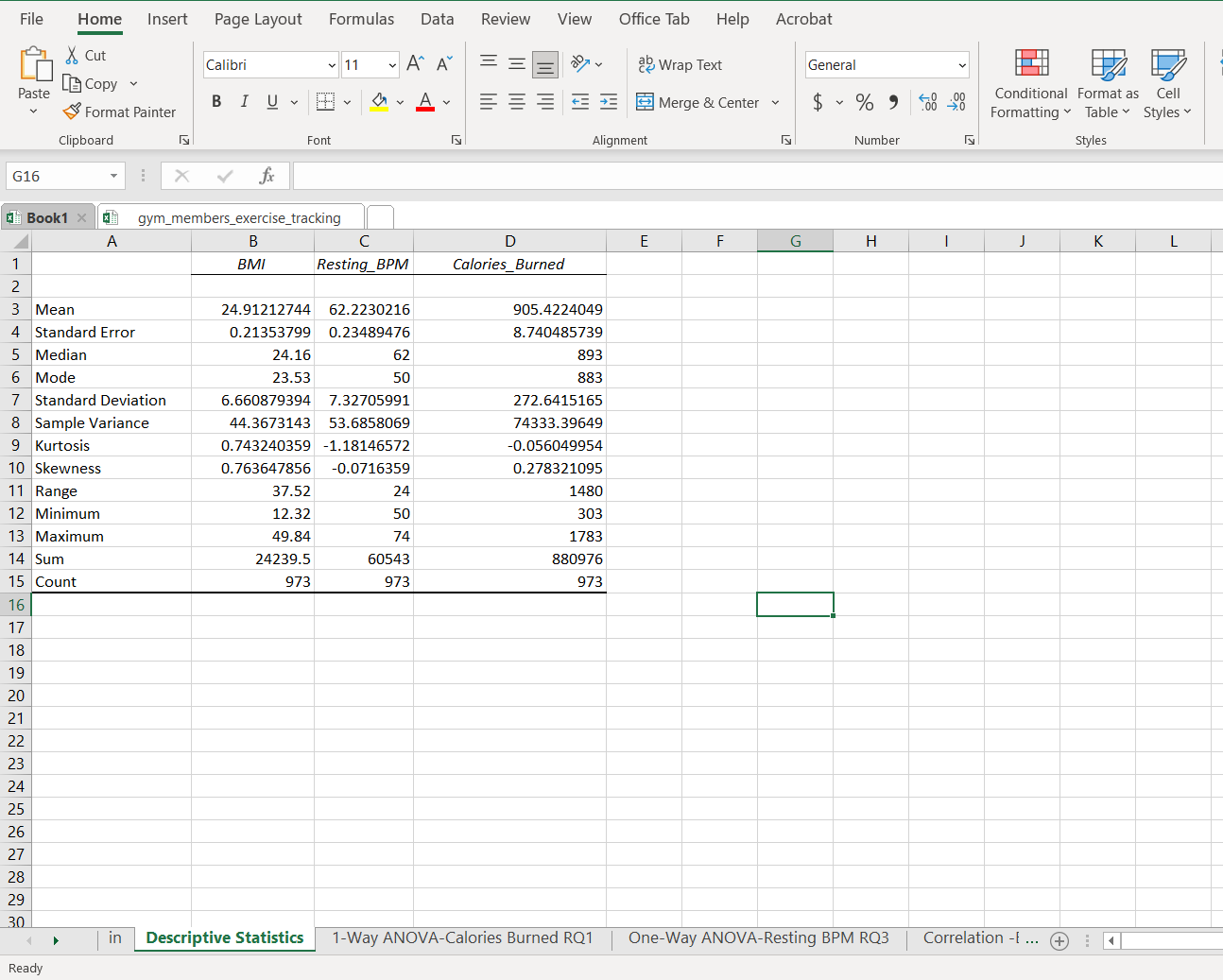
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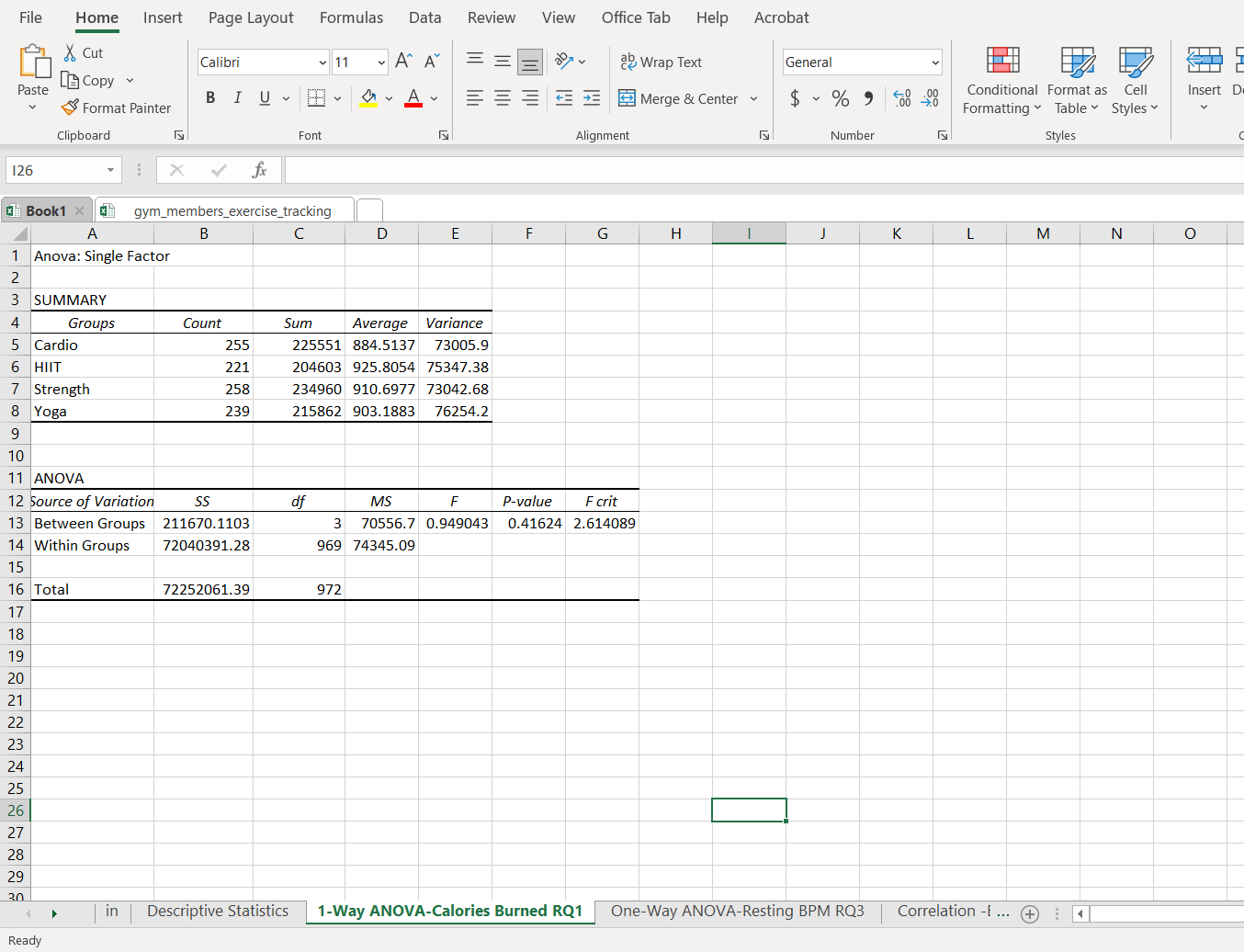
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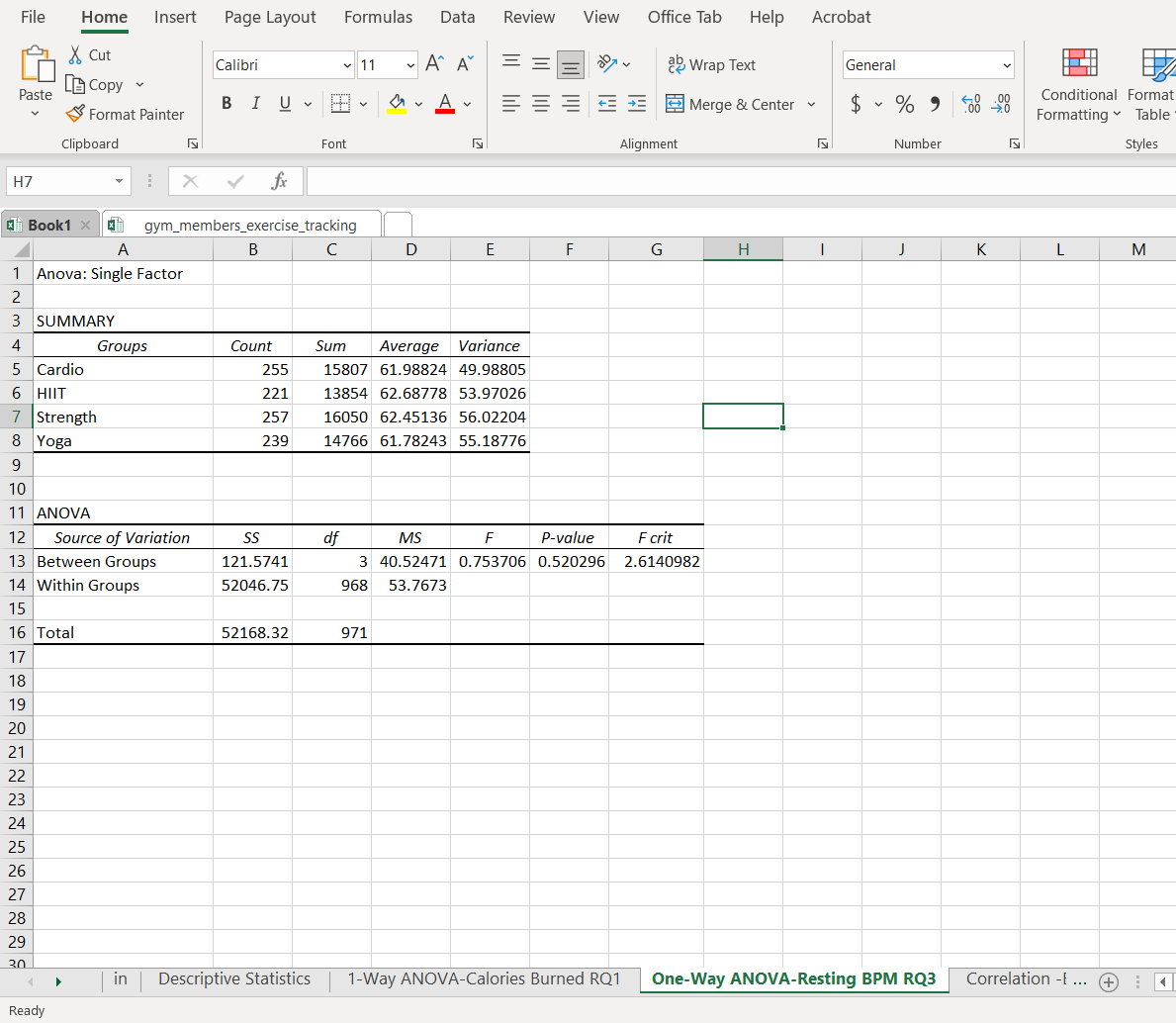
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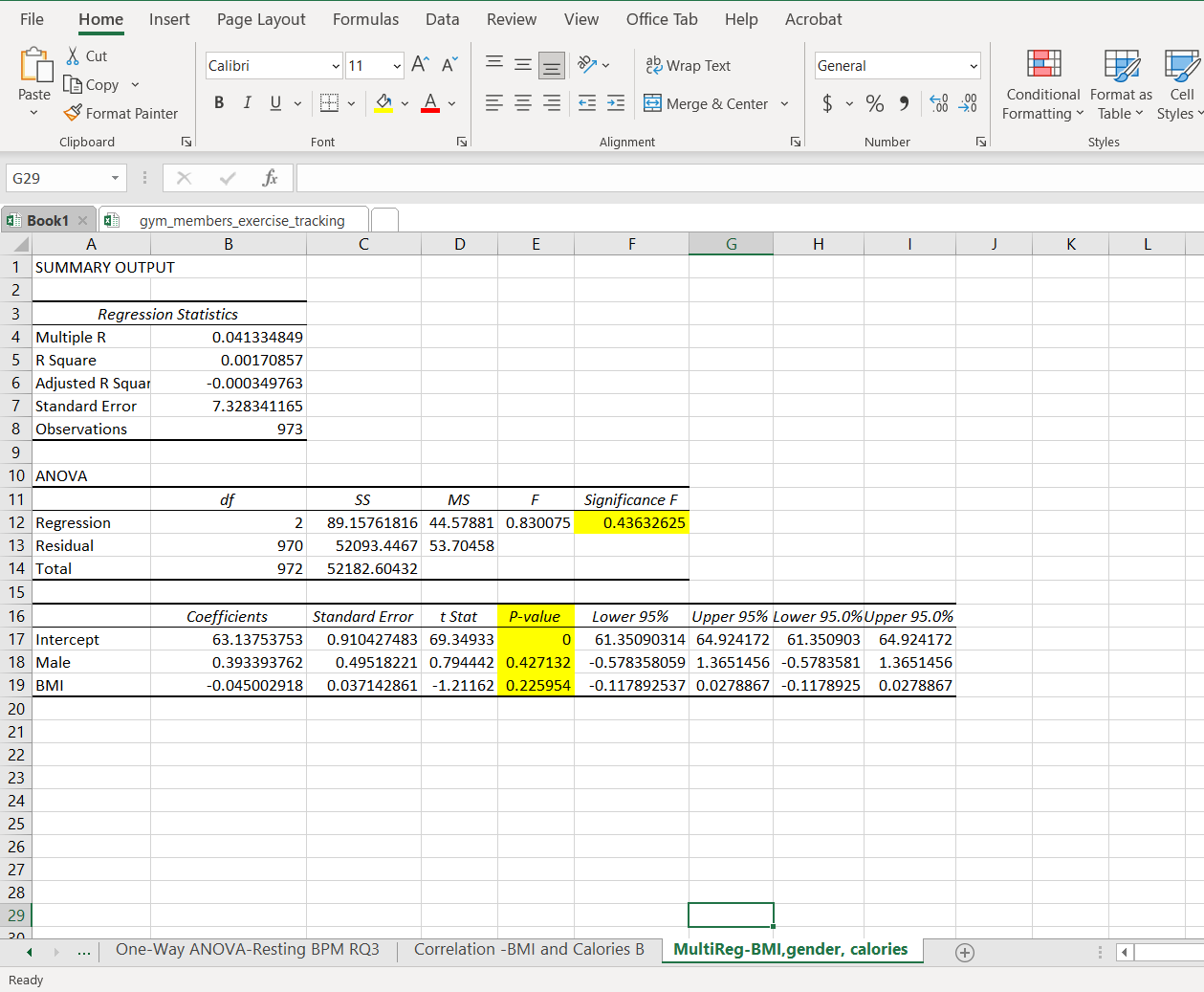
**Appendices**

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