**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, 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. Personalised programs tailored to the individual's goals and physiological variety might maximise health benefits. Further research is needed to explore additional variables such as exercise intensity and age.

**Introduction**

**Background**

It is relevant to note that physical activity and exercise are core aspects of health management that create benefits along physical, psychological, and social lines. With the increasing global focus on healthful living, there would be increased interest in knowing just how much exercise impacts fundamental psychometric variables, including caloric expenditure and resting heart rate. Resting heart rate, as a predictor of cardiovascular health and mortality, is significantly influenced by regular exercise, particularly endurance training and yoga, both of which consistently lower RHR levels (Reimers et al., 2018). Additionally, the role of exercise in modulating caloric expenditure is crucial for managing obesity, which has become a pervasive issue in modern societies (Binsaeed et al., 2023). Notably, factors such as body mass index (BMI) and workout type significantly impact these exercise outcomes, shaping the effectiveness of training regimens tailored to individual needs (Oxford Academic, 2020). These insights underscore the importance of evaluating how exercise variations affect health metrics among gym-goers, particularly in dynamic settings.

**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 interact in their influence on the caloric expenditure and resting heart rate of gym members. 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**

A combination of descriptive, bivariate, and multivariate analyses was used to test the hypotheses, borrowing techniques from CXOLearningAcademy (2020). Descriptive statistics summarized the data; thus, information on means, standard deviation, and distributions concerning, among other things, BMI, calories burned, and RHR was derived. Thus, it pointed out, for example, the variation in the levels of BMI among the categories of workouts, showing a base on which other sets of hypotheses have been tested.

Bivariate analysis methods included one-way ANOVA and correlation analysis. One-way ANOVA was used to test the influence of the exercise modality on calories burned (RQ1) and the resting heart rate (RQ3) since it was appropriate to test means between categorical groups. The test of a linear relationship between BMI and calories burnt (RQ2) used a correlation analysis that provided data on the direction and strength of this relationship. For instance, it was expected that high BMI would positively relate to high caloric expenditure because it necessitates more energy (Laerd Statistics, 2018)

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Multivariate analysis used multiple linear regression to predict resting BPM based on BMI and gender (RQ4). Regression was considered because it could measure not only the effect of continuous and categorical variables but also their combined effect on a dependent variable. Since the analysis controlled for gender, the specific effect of BMI was accounted for, thus providing valid and interpretable results.

**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.

**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 (RQ4)**

The regression model using both BMI and sex as predictors of Resting BPM was not significant, R² = 0.0017, p = 0.436. Neither BMI, p = 0.226, nor sex, p = 0.427, was a significant predictor.

* Statistical Interpretation: This regression model explains only a 0.17% variation in the Resting BPM, which means this model is unable to predict Resting BPM using only BMI and Gender.
* Non-Statistical Interpretation: Resting BPM is more of a reflection of age, cardiovascular conditioning, or lifestyle habits.

1. MultiReg-BMI,gender, calories

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.041334849 |  |  |  |  |  |  |  |
| R Square | 0.00170857 |  |  |  |  |  |  |  |
| Adjusted R Square | -0.000349763 |  |  |  |  |  |  |  |
| Standard Error | 7.328341165 |  |  |  |  |  |  |  |
| Observations | 973 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 2 | 89.15761816 | 44.57881 | 0.830075 | 0.43632625 |  |  |  |
| Residual | 970 | 52093.4467 | 53.70458 |  |  |  |  |  |
| Total | 972 | 52182.60432 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 63.13753753 | 0.910427483 | 69.34933 | 0 | 61.35090314 | 64.924172 | 61.350903 | 64.924172 |
| Male | 0.393393762 | 0.49518221 | 0.794442 | 0.427132 | -0.578358059 | 1.3651456 | -0.5783581 | 1.3651456 |
| BMI | -0.045002918 | 0.037142861 | -1.21162 | 0.225954 | -0.117892537 | 0.0278867 | -0.1178925 | 0.0278867 |

**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.

**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?**

Pearson's correlation between the two sets of variables, calories burned and BMI, is 0.0598, which supports a very weak positive relationship. This implies that the BMI only minimally contributes to the amount of calories burned during the regime of exercise. Such findings therefore suggest that individuals with different BMIs burn roughly the same amount of calories from similar physical activities. Indeed, the American Council on Exercise reports that while body weight can affect the overall number of calories being burned off, such variables are less important than others, such as exercise intensity and exercise duration.

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

One-way ANOVA revealed 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.

Overall, the analyses tend to support the view that exercise type has a negligible effect on both caloric expenditure and resting heart rate. Similarly, BMI has no strong influence in affecting either caloric expenditure or heart rate at rest. These showcase the need to include other factors such as the intensity of the exercise, duration, and even fitness level when comparing various physical activities.

**Conclusion and Implications**

The study has fully explored the set research goal in an attempt to analyse the effects of the type of workout and BMI on calories burned and resting heart rate across members of the gym. The output derived indicates that while HIIT does show the tendency of always having the highest expenditure of calories, overall, there isn't any real difference across the types of workouts. It may give relevance to only the individual factors of workout intensity and time. BMI positively related to the calories burned, yet did not predict resting heart rate. In the same way, there was no statistical difference in the type of yoga regarding a change in resting heart rate, again reflecting its purpose and benefit toward cardiovascular and relaxation elements.

The implications for fitness trainers and gym members are far-reaching. Individualized workout plans should emphasize duration and intensity over the type of exercise to achieve caloric and cardiovascular goals. For example, trainers could incorporate HIIT for clients prioritizing weight loss due to its high calorie-burning potential. Conversely, those aiming to enhance cardiovascular health might benefit from the long-term integration of yoga or endurance-based activities. These approaches somehow reflect the understanding that the effectiveness of the exercises is less about the category of workout but rather tailoring the routines to personal objectives and physiological responses.

However, the inferiority of the dataset-for instance, not including the duration or intensity of the workout-already limits such an analysis to the mere supposition of what could influence the two variables at hand: calories burned and resting BPM. Further research might be done to fill in such gaps by considering the inclusion of such variables. Further research into the role of age, metabolic rate, and experience with fitness may yield further valuable insights into the response differences to similar exercises that some persons experience. These inclusions would make the findings more applicable to the planning of better fitness and health.

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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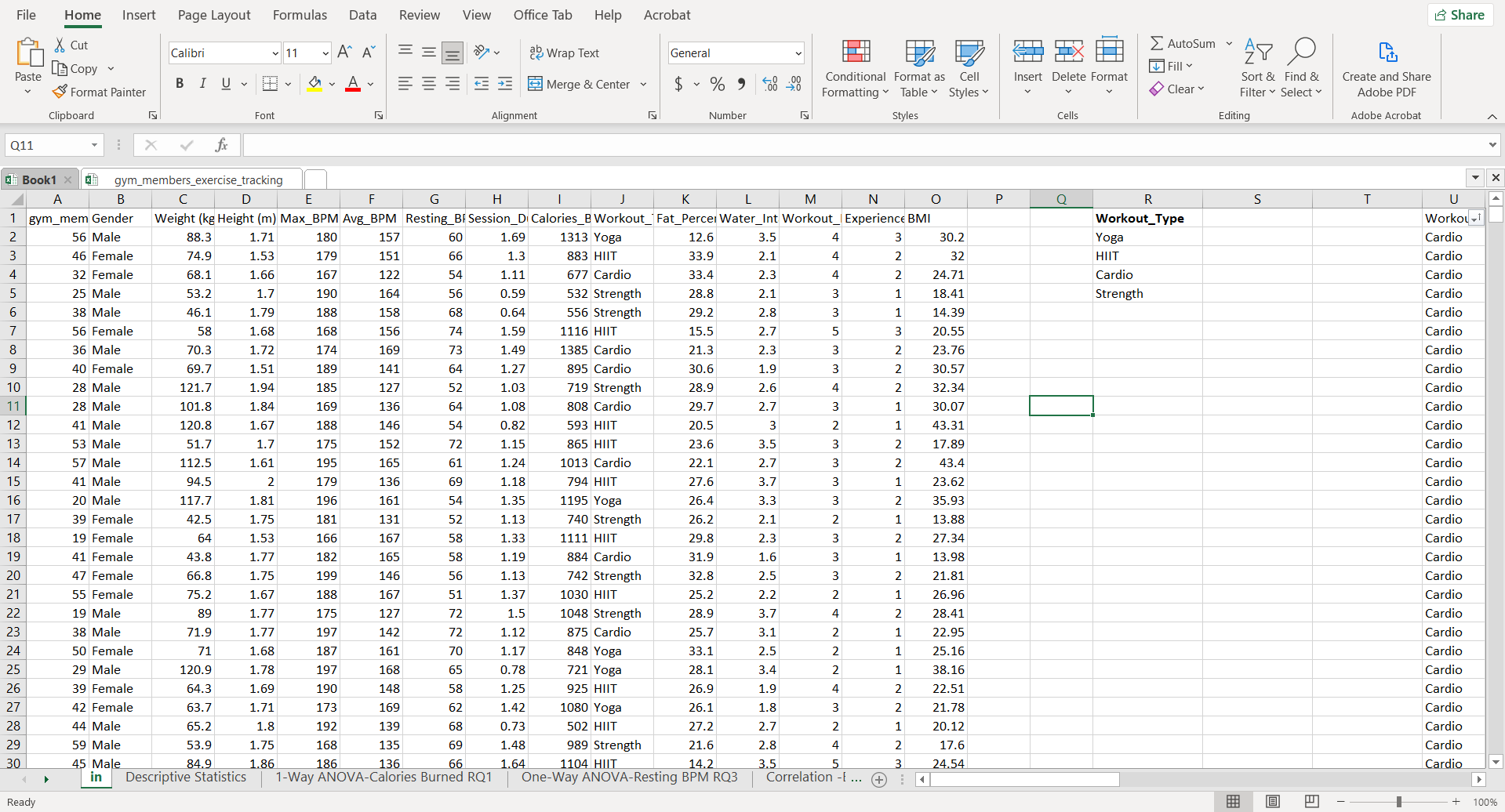
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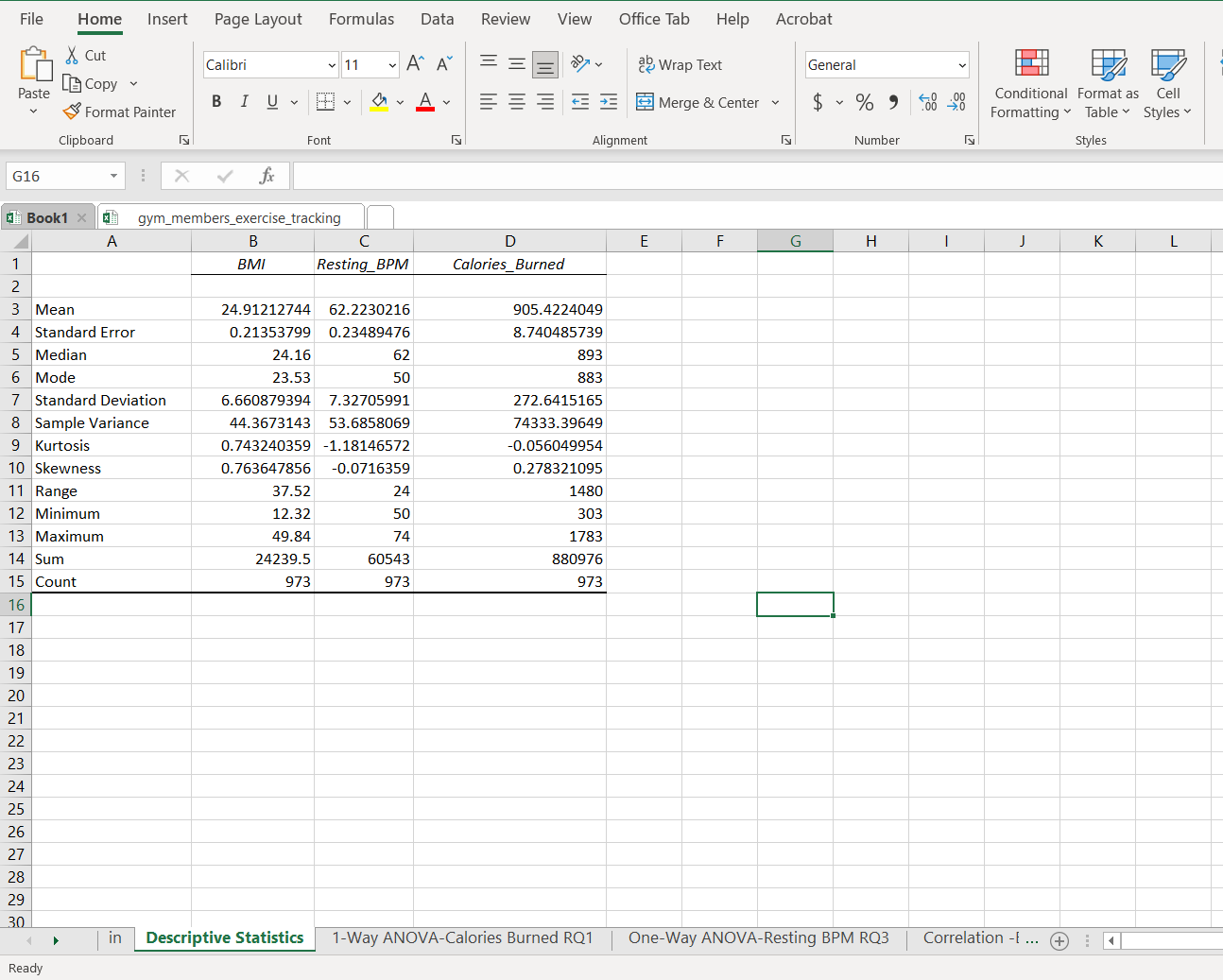
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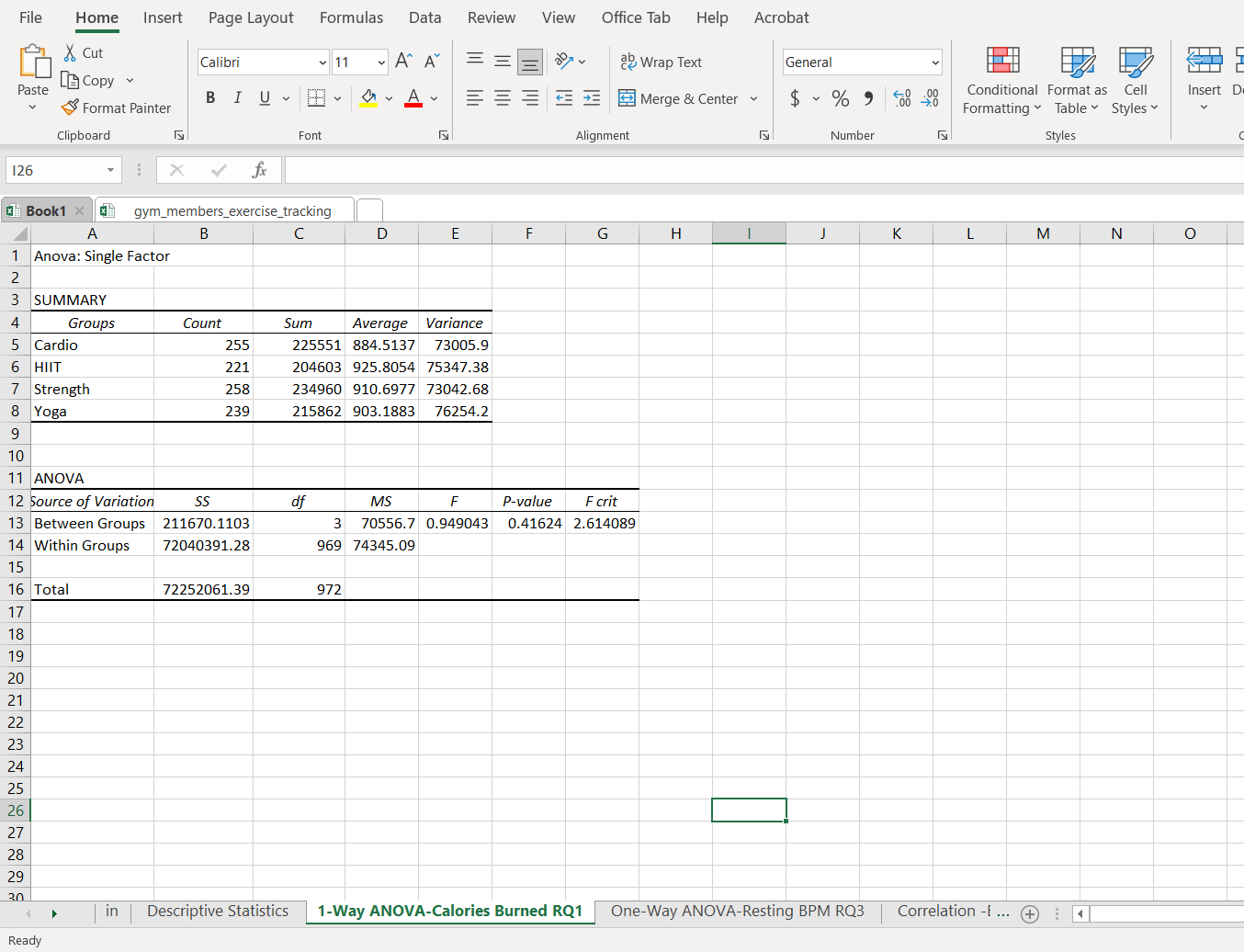
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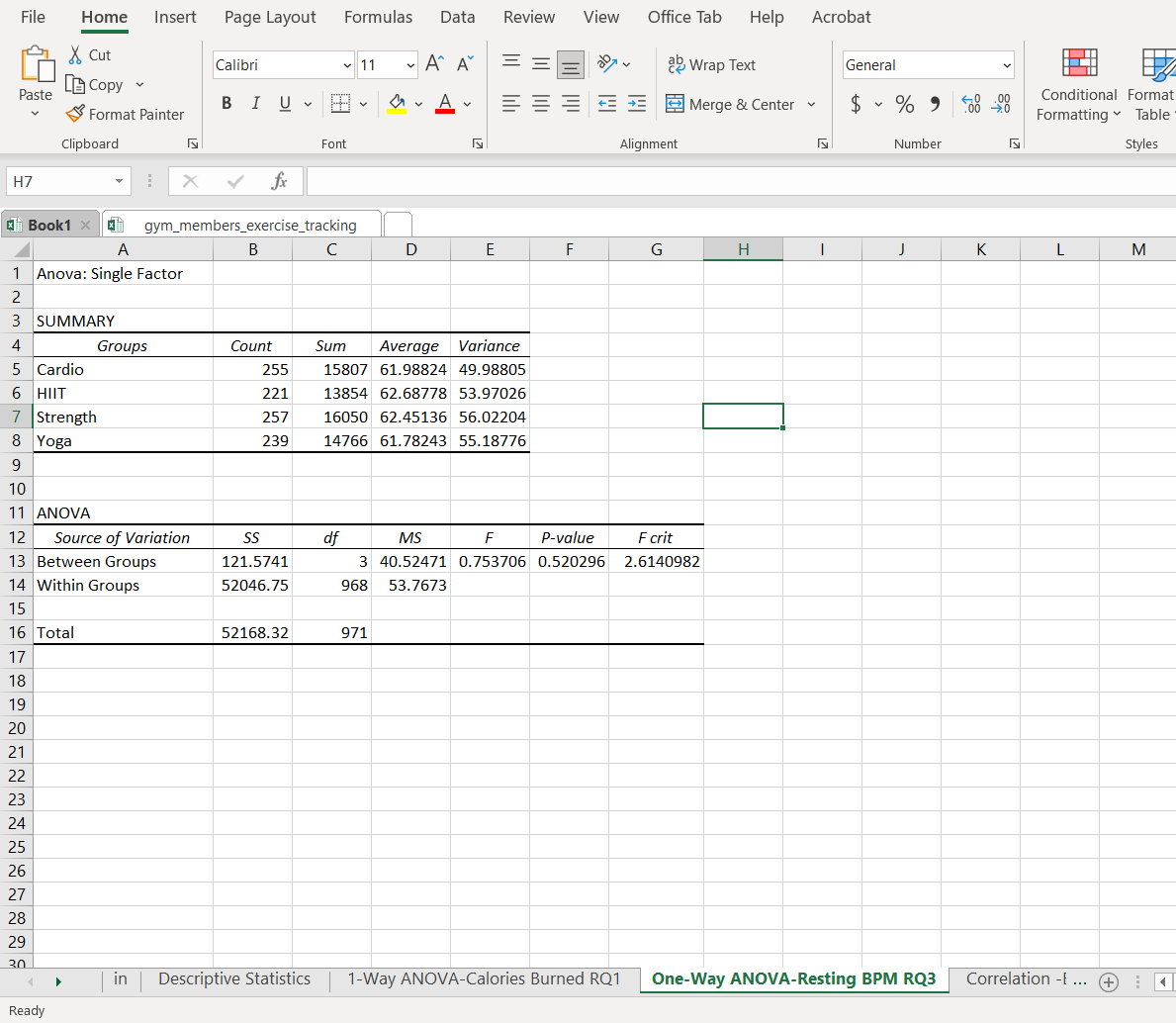
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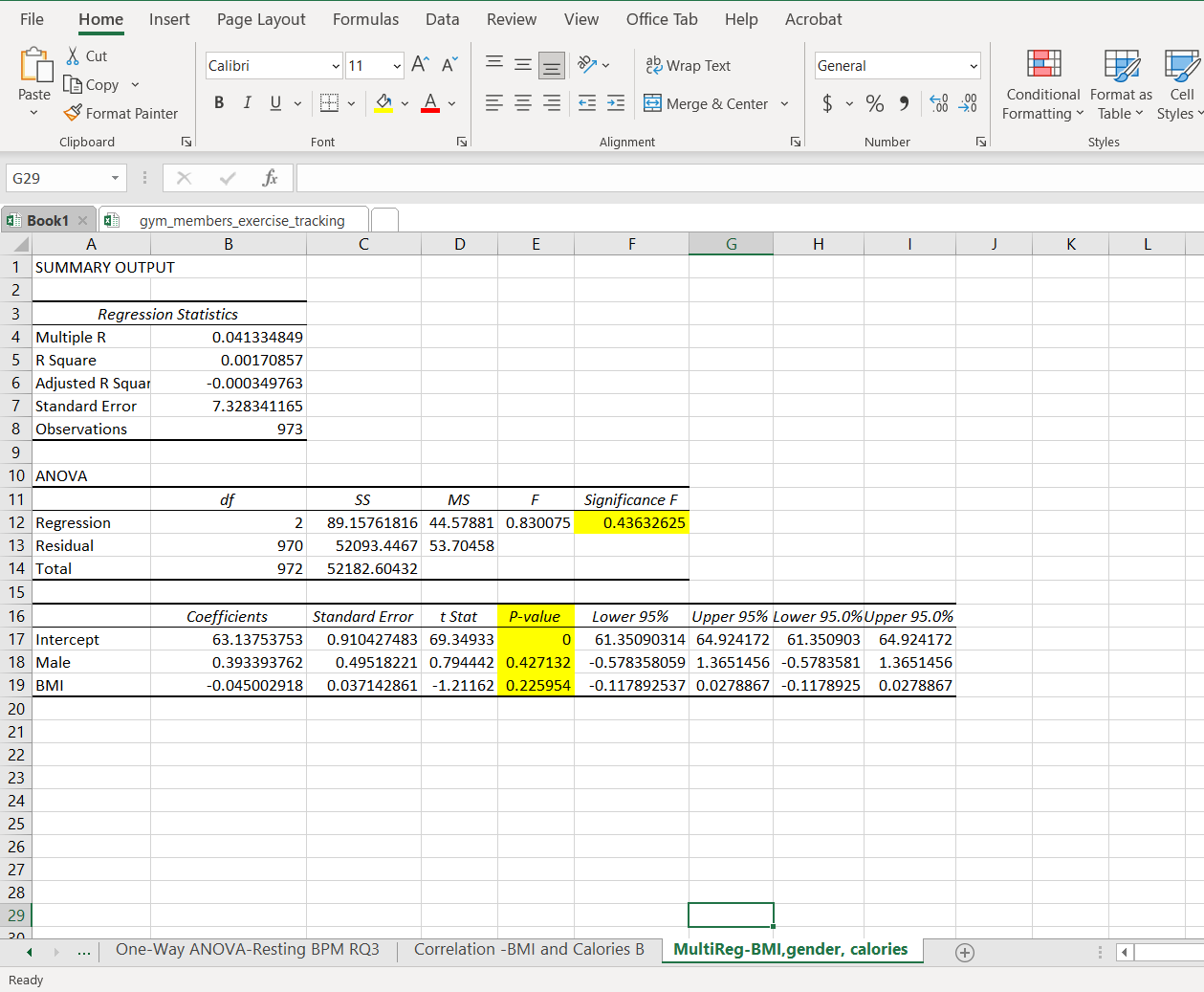
**Appendices**

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