WEIGHTLOSS SIMULATION DUE TO EXERCISE INTENSITY

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Abstract

Exercise is renowned and discussed every time weight loss comes up. How much does two varying exercises truly affect weight loss with all other constraints constant? This simulation attempts to understand the affects two intensities of exercise has on BMR, weight-weight loss and duration it takes to reach a goal weight. Using MET values (way to determine intensity of exercise) of 3.5 (moderate) and 7 (high intensity of exercise). These two MET values represent a leisure walk (3.5 MET) and an intense cardio activity like a fast run (7 MET). While it takes 3,500 calories to burn through a pound of fat no matter what exercise you do, the rigorous exercise scenario achieved the goal weight in 585 days, less than half the time compared to moderate exercise which took 1,170 days when exercising for 30 min each day.

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Introduction

Exercise is known for its benefits for people's health overall. It is constantly advertised that if people want to improve their health, or more often their weight, they should exercise. Exercise comes in many forms: walking, running, bicycling, etc. Which one should people do to optimize results? Using Basal Metabolic Rate (BMR) calculations and MET estimates for intensity, this paper analyzes the comparison between doing a moderate activity and a high intensity activity for 30 minutes every day.

Literature Review

As computational abilities have increased over the past few decades, models simulating the effects of exercise on the human body have also increased their complexity and capability. A great study for its time was done in 2006 on modelling a single type and duration of exercise and its effects on hormones and energy supply within the body. The study had a fixed output for exercise and mainly looked at the consumption of carbohydrates and lipids and their effects on blood sugar during and after exercise (Kim et al 2006).

Since 2006, simulation has continuously been used to further understand the effects of exercise on the body and its complicated nuances. An article published in PLOS Computational Biology Journal, details a model created in 2018 that explored in further detail the person's characteristics compared to the model developed in the 2006 article by Kim et al mentioned above (Palumbo et al 2018). This more detailed research was able to shed further light on exercises affects on the body particularly on hormones such as insulin. The simulations aligned with other research completed using real test subjects, sometimes coming in above or below their estimates but in similar clusters. In other words, the study was successful and not wildly out of bounds from other studies, but was not perfect 100% of the time, as a simulation rarely is.

Methods

This research will simulate the effects on body weight due to two different exercise intensities. An assumption for this simulation is that the individual is eating calories the same as they are expending as their BMR. Therefore, BMR is only used in this simulation to determine the effects of exercise over time on someone's weight and is not being used to calculate calories in as both values cancel each other out day by day. In other words, exercise is the only change in

calorie values in this simulation. Calories due to food consumption is not included in this simulation.

For each day:

1. Calculate total calories burned through exercise by using weight values from the day before:
    a. Calculate calories expenditure with exercise. Constant 30 minutes regardless of intensity. Case 1: Moderate exercise with a MET value of 3.5. Case 2: Vigorous exercise with a value of 7. MET values sourced from: *MarathonHandbook.com.* Function to calculate calories burned through exercise can be found in the appendix in Appendix A.
2. Given the calories burned through exercise, calculate the amount of a pound was burned off the body (theoretically). Calculate the new BMR for the person at that new weight for day. The formula to calculate calories burned through exercise can be found in Appendix b.
3. For each day until the current weight is the same as the goal weight output in a data frame the: day, case, weight for that day, calories burned from exercise, and new BMR value for that day.

Results

It took 585 days to reach a goal of 165 pounds using rigorous exercise, and 1,170 days using moderate exercise as displayed in Figure 1. The calories burned were roughly the same where moderate exercise burned 185559.5 calories total and rigorous exercise burned 185578.67 calories total. This makes sense as it is standard that 3500 calories burned = pound. The difference here is that rigorous exercise burns through the calories quicker than moderate exercise. Since the simulation spans years and BMR is affected by age which then BMR then affects how much weight is lost due to exercise each day, changing age by years was also considered where roughly 5 calories were lost in BMR rate every year. These abrupt changes can be seen in figure 2 where there are drops in BMR every 365 days.

Figure 1: Weight changes over time due to rigorous and moderate exercises.

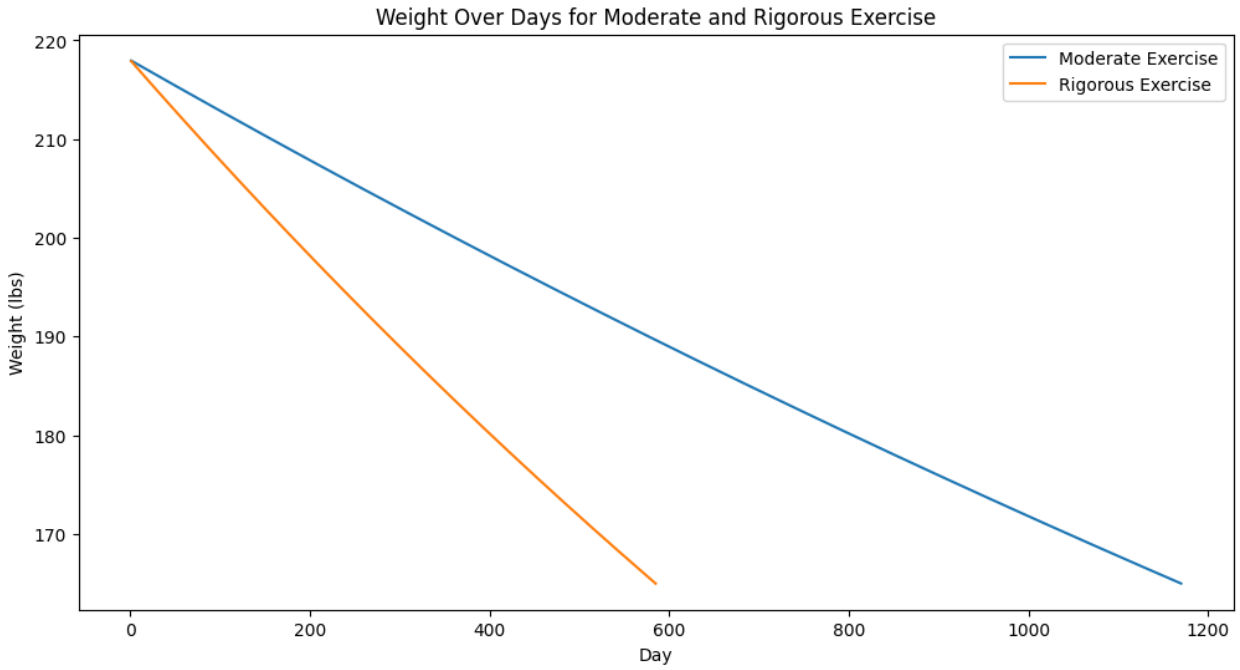
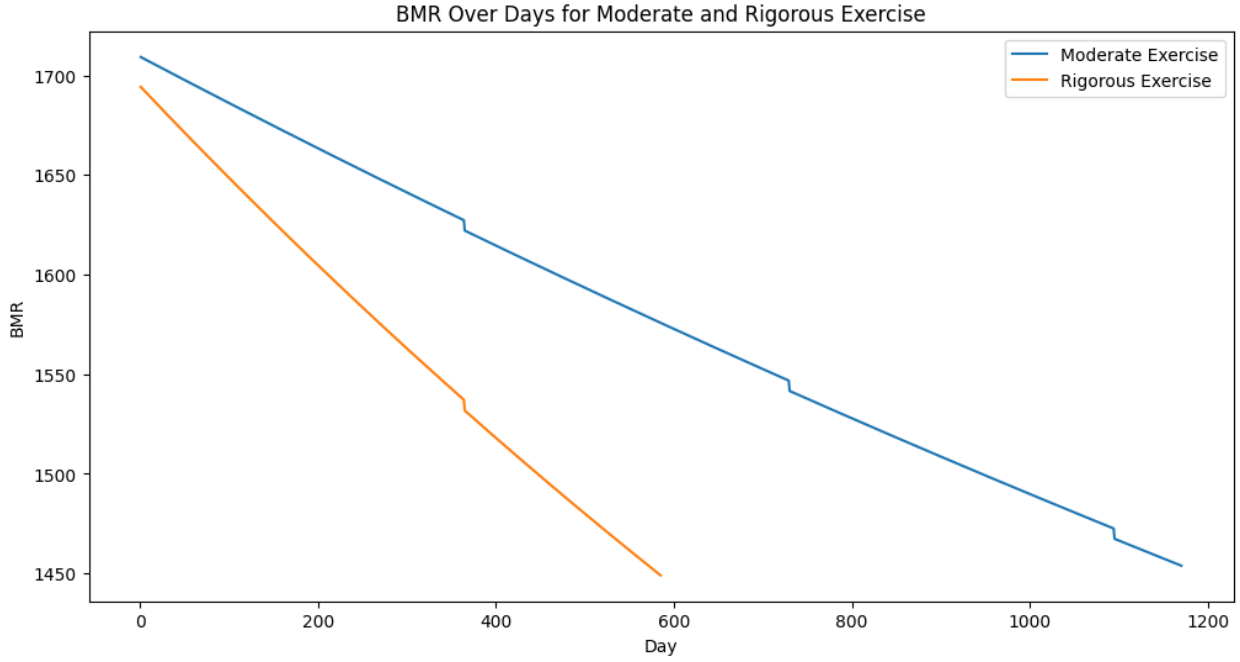


Figure 2: BMR changes over time due to decreased body weight and age.



Conclusions

When simulating two cases of exercise intensity on the same individual, it's clear the more rigorous the exercise the quicker the person will reach their ideal weight. However, this is a very, very simplified simulation due to technical difficulties. This does not take into consideration health conditions that could cause a lower BMR, water weight fluctuations, food consumption, food macros, and much more could be added to this simulation.

When I first set out to do this simulation, I wanted to demonstrate the effects on weight loss while also simulating changes in calorie consumption. I was trying to do too much at once and got very turned around. This presentation of work is the first step in trying to get to that endgame – simply simulate the affects of exercise intensity on a person over time. My next step is to add variations in diet, particularly calories consumed. I would also like to explore the effects on muscle mass certain exercises and protein consumption can have.

References

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Kim, Jaeyon, Gerald M. Saidel, Marco E. Cabrera. “Multi-Scale Computational Model of Fuel Homeostasis During Exercise: Effect of Hormonal Control” Springer Nature Publishing. Published November 17, 2006. Date Accessed December 3, 2024.

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Appendix A

Appendix A:

```python
# Function to calculate BMR
def calculate_bmr_lbs(weight, height, age, gender):
    if gender == 'female':
        return (4.536 * weight) + (15.88 * height) - (5 * age) - 161
    else:
        return (4.536 * weight) + (15.88 * height) - (5 * age) + 5
```

Appendix B:

```python
# Function to calculate calories burned
def calculate_calories_burned(met, weight, time):
    weight_kg = weight / 2.20462
    return (time * met * 3.5 * weight_kg) / 200
```