

# The Hybrid Protocol: A 10-Week Case Study on the Interaction Between Strength Training and Endurance Performance

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**Abstract**—This study investigates the efficacy of a 10-week Strength-Focused Upper/Lower Split program in eliciting simultaneous gains in musculoskeletal strength and endurance running speed. Employing a longitudinal single-subject case study, the researcher implemented a four-day resistance training split combined with a weekly 5k run to examine the presence of the “interference effect” in a hybrid training regimen. Analytical methods, including Pearson correlation and simple linear regression, were used to explore associations between training volume, recovery metrics, and performance outcomes. The results revealed a marked increase in strength capacity, evidenced by a 120% improvement in leg press volume ( $p = 0.0013, R^2 = 0.7443$ ). Cardiovascular performance also improved, with a 20% enhancement in efficiency and an average 5k pace reduction of 11.7 seconds/km per week ( $p = 0.0063, R^2 = 0.6281$ ). A moderate negative correlation ( $r = -0.5265$ ) between leg training volume and run pace suggested no interference effect; rather, enhanced lower-body strength may complement endurance performance. Furthermore, running performance was influenced by recovery quality, notably Saturday night sleep ( $r = -0.5289$ ). These findings refute the null hypothesis and demonstrate that a structured hybrid protocol can yield significant, concurrent improvements in both strength and endurance over a short timeframe.

**Index Terms**—Concurrent training, hybrid athlete, interference effect, linear regression, Pearson correlation, progressive overload, sports analytics

## I. INTRODUCTION

Physical fitness refers to the capacity to perform daily activities with energy and concentration, without experiencing premature fatigue. Historically, the fitness community has been divided between individuals who prioritize hypertrophy and maximal strength (“lifters”) and those who focus on aerobic capacity and endurance (“runners”). Recent developments in athletic training emphasize a holistic, hybrid approach that integrates multiple training modalities to foster a resilient, adaptable physique [1].

Despite the advantages of a versatile training regimen, most individuals continue to specialize in a single discipline, either pursuing muscle hypertrophy through strength training or enhancing speed through endurance exercises [2]. This tendency toward specialization is frequently attributed to the “interference effect,” a physiological phenomenon in which adaptations

to endurance training can inhibit signaling pathways required for muscle hypertrophy and strength development [3].

This study evaluates the effectiveness of a 10-week Strength-Focused Upper/Lower Split protocol intended to produce measurable improvements in both maximal strength and endurance running speed. Building on the discussion of hybrid training approaches, a distinctive feature of this protocol is the inclusion of a single, fixed-distance run at the end of each week. This limited running frequency is intended to assess whether consistent lower-body strength training correlates with improvements in running speed, even when running is performed only once per week. By employing a high-repetition, moderate-weight approach, the project seeks to quantify the extent of concurrent fitness gains achievable through this regimen.

The primary issue this project addresses is the lack of detailed, individual-focused analysis in existing fitness research. Most previous studies on the interference effect rely on generalized trends rather than longitudinal, individualized data [4]. This project addresses this gap by utilizing self-recorded, continuous data to identify which factors, such as training volume or recovery, most accurately predict performance outcomes.

The primary objective of this study is to quantify the total percentage improvement in the Sunday 5k run and three key strength metrics using linear regression to determine if concurrent gains are statistically significant.

### Secondary Objectives

- To demonstrate and quantify progressive overload by tracking the percentage increase in total training volume and maximum repetition weight for the Leg Press, Incline Bench Press Machine, and Assisted Pull-Up Machine.
- To analyze the relationship between Total Lower Body Volume ( $TL_v$ ) and running speed, in order to determine whether increased leg training is inversely related to running speed, thereby assessing the efficacy of the hybrid protocol.
- To determine the correlation between Saturday sleep duration and Sunday running performance, with the aim

of identifying whether recovery is a significant predictor of cardiovascular output.

This project addresses the following specific research questions:

- What is the total percentage change in strength, training volume, and running pace over a 10-week period when following a hybrid training protocol?
- Does a high-volume lower-body resistance training routine significantly hinder running speed, or is it associated with improved endurance performance when running occurs once per week?
- To what extent does Saturday night sleep duration correlate with Sunday morning 5k performance, and can it serve as a reliable predictor of running outcomes?

Null Hypothesis ( $H_0$ ): The structured hybrid training protocol will result in no significant percentage improvement in average run pace or the three measured strength metrics (Leg Press, Incline Bench Machine, Assisted Pull-Up Machine) over the 10-week period.

Alternative Hypothesis ( $H_1$ ): The structured training split will result in a significant and simultaneous positive percentage improvement in both speed and all three measured strength metrics over the 10-week period.

## II. LITERATURE REVIEW

Performance in a hybrid training model is influenced by several critical factors, particularly the interaction between resistance training volume and cardiovascular exercise frequency [5]. Identifying patterns in these variables through data science provides a more nuanced understanding of performance trends than traditional, generalized coaching methods.

### A. Strength Training and "Newbie" Gains

Strength training is fundamental for inducing muscular contractions that increase strength and size. For beginners, the first six to twelve weeks of training often result in rapid increases, often called "newbie gains," driven largely by improved neurological adaptations as the body learns to activate motor units more efficiently [6]. During these structured 10-week periods, individuals typically demonstrate significant progressive overload by tracking the percentage increase in max rep weight for primary compound lifts, such as the Leg Press and Bench Press [7].

### B. Cardiovascular Endurance with Minimal Frequency

Running is recognized as an effective method of aerobic exercise, but its impact is closely related to both volume and frequency. Research indicates that, although running only once per week is minimal, it may still provide measurable benefits for individuals establishing a new fitness baseline [8]. In these cases, emphasis is placed on maintaining speed and quantifying improvements in time over a fixed distance. While elite athletes require more frequent sessions for significant improvements, those with slower baseline times may experience rapid initial reductions in average pace simply by increasing overall weekly activity [9].

### C. The Interference Effect and Lower Body Volume

The "interference effect" is a physiological phenomenon suggesting that aerobic endurance training may inhibit the signaling pathways required for muscle hypertrophy and strength [10]. Historically, high-volume lower-body training was thought to be inversely related to running speed. However, modern concurrent training research suggests that strength training—specifically lower-body exercises—can support running pace by improving stride power and economy [11]. By tracking Total Lower Body Volume (TLV), which is the sum of weight, reps, and sets, this study aims to examine if the strength gained from a four-day split can compensate for a low running frequency to still yield a faster run pace [12].

### D. Recovery and Sleep as Performance Predictors

The role of recovery, particularly sleep, is another dominant predictor found in athletic literature. Researchers like Bird have concluded that sleep deprivation significantly impairs physiological recovery and power output [13]. Most studies reach these conclusions through survey-based methods or clinical sleep trials, finding that consistent sleep (7–9 hours) is vital for injury prevention and metabolic health [14]. This project integrates this variable by specifically analyzing the correlation between Saturday night sleep and Sunday morning performance, testing if recovery duration serves as a reliable predictor for endurance output in a real-world setting.

### E. Data Science in Personal Performance Tracking

The advancement of personal data tracking through specialized applications like Strava has allowed data science to provide the tools necessary to analyze and predict performance trends. While prior studies in sports analytics have used Correlation Analysis and Linear Regression to handle complex datasets, they are often applied to professional teams or large-scale health surveys [15]. This project builds on these established methods by applying Pearson Correlation and Linear Regression to a single-subject 10-week dataset. This approach fills the gap left by generalized surveys by using continuous, self-recorded data to identify whether Total Lower Body Volume ( $TL_v$ ) or Sleep is the dominant predictor of specific speed improvements.

## III. METHODOLOGY

This chapter outlines the systematic approach used to monitor my physical changes throughout this 10-week self-study. The project relies on a continuous tracking model, where I recorded my performance in every session to identify long-term trends in my fitness. By using standardized measurement steps, such as employing the same running route and lift protocols, we ensure that the final analysis provides a reliable look at how a hybrid routine works for an individual.

### A. Participants

The study involved a single participant: the researcher, who served as the primary subject. The participant is a 21-year-old Filipino male and a fourth-year Bachelor of Science

in Computer Science student at National University Manila, specializing in Machine Learning. Prior to the study, the participant maintained a generally active lifestyle consisting of regular resistance training, however, he reported a lack of consistency in lower-body training and minimal experience in distance running or jogging.

### B. Data Collection Methods

The data collection for this study focuses on monitoring the relationship between resistance training volume, cardiovascular performance, and recovery metrics. The dataset was compiled over a 10-week period to analyze concurrent training adaptations.

TABLE I  
DATASET INFORMATION

Variable	Type	Unit	Frequency	Tool
Week	Qualitative	Week No.	Weekly	Spreadsheet
Date	Qualitative	Day-Month-Year	Weekly	Spreadsheet
Split	Qualitative	Upper A, Lower A, Running	Weekly	Phone Notes, Heavy, Spreadsheet, Strava
Focus_Lift	Qualitative	Incline Bench Machine, Assisted Pull-up Machine, Leg Press, Sk	Weekly	Phone Notes, Heavy, Spreadsheet, Strava
Set_Details_lbs	Quantitative	Weight x Sets	Weekly	Phone Notes, Heavy, Spreadsheet
Max_Rep_Weight_lbs	Quantitative	Max Weight in Pounds	Weekly	Phone Notes, Heavy, Spreadsheet
Total_Volume_lbs	Quantitative	Total Volume in Pounds	Weekly	Phone Notes, Heavy, Spreadsheet
Saturday_Sleep_Hours	Quantitative	Hours	Every Saturday	Phone
Run_time	Quantitative	Mins:Seconds	Every Sunday	Strava
Pace_min_km	Quantitative	Mins:Kilometer	Every Sunday	Strava

### C. Operational Definitions

This dataset monitors physical progress over the course of a 10-week fitness program by combining strength, endurance, and recovery statistics. Training volume is recorded along with indicators like sleep and running speed, providing a clear picture of how consistency and rest affect performance.

- **Week:** A numerical tracker (1–10) used to observe progress over the course of the program.
- **Date:** The calendar date of the entry, recorded as a string (e.g., "01/12/2025").
- **Split:** The category of the workout session, distinguishing between different training focuses like **Upper A**, **Lower A**, or **Running**.
- **Focus\_Lift:** The specific exercise being measured, ranging from compound movements like **Leg Press** to endurance activities like a **5k**.
- **Set\_Details\_lbs:** The raw performance log for each set, recorded in a **weight x reps** format (e.g., "88x10, 88x8").
- **Max\_Rep\_Weight\_lbs:** The peak weight lifted during a single set for that specific exercise.
- **Total\_Volume\_lbs:** The sum of the entire training load (calculated as \$Weight \times Reps\$ for all sets).
- **Run\_Time:** The total duration of a 5k run (HH:MM:SS).
- **Pace\_min\_km:** The average speed per kilometer; this is converted into **Pace\_sec** within the notebook to allow for statistical correlation.
- **Saturday\_Sleep\_Hours:** A recovery benchmark measuring sleep duration specifically on Saturday nights to correlate rest with performance.

### D. Data Cleaning

The data preprocessing phase involved standardizing units and transforming raw variables to ensure consistency and

suitability for statistical analysis. The following methods were employed:

- **Metric Conversion:** All weight-related data was converted from pounds to kilograms (lbs / 2.2 = kg) to ensure unit consistency and improve readability across the dataset.
- **Feature Engineering:** To convert the running pace into a format compatible with numerical analysis, the original "min:km" entries were transformed into a total seconds column (pace\_sec) using the formula:  $(minutes \times 60) + seconds$ .
- **Dimensionality Reduction:** Non-numeric and redundant variables were removed to refine the dataset for modeling. This involved dropping columns such as date, run\_time, pace\_min\_km, and all original imperial measurements (set\_details\_lbs, total\_volume\_lbs, and max\_rep\_weight\_lbs).
- **Missing Value Analysis:** An audit of the dataset was conducted to quantify null entries. This step was used to evaluate the data structure and ensure that missing values did not compromise the integrity of the statistical results.

### E. Statistical Analysis

The correlations and trends among the training variables were examined using statistical techniques. The direction and degree of connection between recovery parameters and physical performance were determined using Pearson Correlation. The Pearson Correlation Coefficient (r) can be found using the following formula:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}} \quad (1)$$

Where:

- $x_i$  and  $y_i$  - are the individual sample points for variables such as Saturday Sleep Hours and Sunday Running Pace.
- $\bar{x}$  and  $\bar{y}$  - are the mean values of the respective variables.

The **Pearson test** was selected because the variables (Volume, Pace, and Sleep) are quantitative, allowing for a linear assessment of how recovery influences performance.

**Simple Linear Regression** to model the progression of strength and endurance over the 10-week period. This allowed for the calculation of the "rate of improvement" per week. The regression formula is:

$$Y = \beta_0 + \beta_1 X + \epsilon \quad (2)$$

Where:

- $Y$  is the dependent variable (e.g., Total Volume in kg or Running Pace in seconds).
- $X$  is the independent variable (Time in weeks).
- $\beta_1$  is the slope, representing the average improvement per week.

Data analysis was supported by a suite of visualizations designed to highlight specific trends and distributions.

- **Heatmaps** identified key correlations between recovery and output.

- **Regression Plots** modeled performance trajectories over the 10-week window.
- **Time-series** progression was captured via **Line Charts** for compound movements
- **Bar Charts** quantified total gains from baseline to conclusion.
- **Histograms with Kernel Density Estimates (KDE)** were applied to assess the distribution and normality of the lifting data.

The regression analysis and P-value testing were used to examine if the observed physical improvements were statistically significant or simply due to random variation.

Because the dataset was compiled from a single individual, the study contains self-reporting bias, particularly for variables such as sleep duration and manual logging of workout sets. While sleep was recorded through personal assessment, there is the possibility of subjective interpretation. Measurement mistakes may also occur due to the quality of gym equipment and the GPS accuracy of the tracking app used for 5k runs.

Furthermore, the limited sample size (N=10 weeks) limits the potential to apply these findings to a larger population, making this an individual case study. These potential biases were identified and taken into account when interpreting the data.

#### IV. RESULTS

The study analyzed the 10-week concurrent training dataset to examine the progression of strength and endurance, as well as the impact of recovery on performance. The results are presented through descriptive statistics, data visualizations, and inferential statistical validation.

1) *Mean, Median, SD*: After data cleaning and filtering for the 10-week analysis window, the dataset tracked three compound lifts and weekly 5k runs.

TABLE II  
DESCRIPTIVE STATISTICS OF TRAINING METRICS

	Total_Volume_kg		Max_Rep_Weight_kg	
	Mean	Std. Dev.	Mean	Max
Assisted Pull-Up Machine	333.72	126.72	12.82	20.32
Incline Bench Machine	1117.65	106.44	45.40	49.90
Leg Press	2661.86	513.89	90.67	110

Table II summarizes the central tendency and variability of the strength exercises, documenting the average volume and peak weights achieved over the 10-week program.

TABLE III  
RUNNING AND RECOVERY SUMMARY

	Pace_sec		Saturday_Sleep_Hours
	Mean	Std. Dev.	Mean
5k Run	442.1	44.57	6.1

Table III provides the baseline statistics for the 5k run pace and Saturday night sleep duration, establishing the mean performance levels for the endurance and recovery variables.

2) *Histograms*: Histograms were used to examine how the values of numerical data, such as Leg Press volume, Incline Bench Machine volume, and 5k running pace, are distributed across all recorded sessions in the 10-week program.

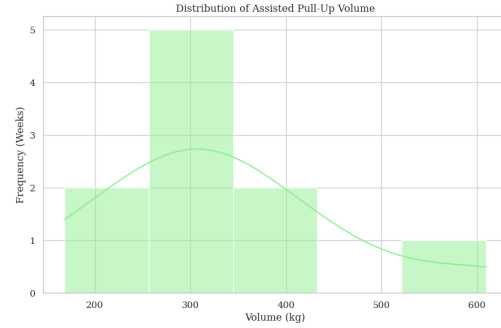


Fig. 1. Histogram Distribution of Assisted Pull-Up Volume

Figure 1 displays the volume for Assisted Pull-Ups. The distribution shows a wider spread with a significant number of sessions at lower "assistance" weights (168–200 kg range). Since lower weight on this machine represents less assistance, this shift demonstrates an improvement in relative bodyweight strength over time.

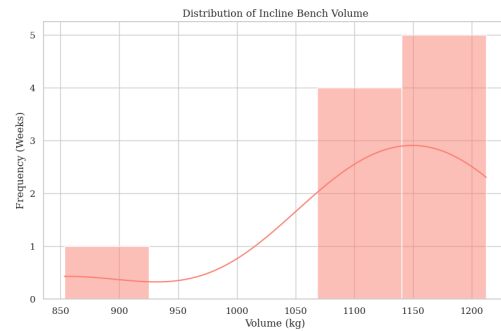


Fig. 2. Histogram Distribution of Incline Bench Volume

Figure 2 illustrates the distribution of the Incline Bench Machine volume. Unlike the Leg Press, this distribution shows a tighter cluster around the 1,100–1,200 kg mark. This indicates a more linear and controlled progression with less variability, reflecting the smaller muscle groups involved in upper body pressing.

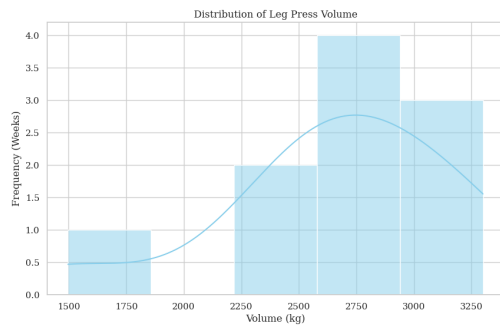


Fig. 3. Histogram Distribution of Leg Press Volume

Figure 3 presents the distribution of your Leg Press volume. The data shows a concentration of values in the 2,500 –3,300 kg range. The distribution is slightly left-skewed, indicating that as the weeks progressed, you spent more sessions at higher intensities, successfully moving away from the baseline of 1,496 kg.

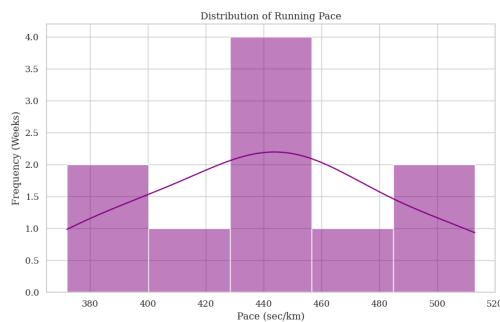


Fig. 4. Histogram Distribution of Running Pace

Figure 4 presents the distribution of your 5k running pace (sec/km). The histogram shows a peak in the 400–450 second range. The presence of values near the 370-second mark represents your peak performance weeks, while higher values above 500 seconds represent the initial baseline weeks.

3) *Time-Series Trends*: Time-series trends were used to visualize and explore how the performance data varied over the 10-week timeline, tracking the trajectory of strength gains and cardiovascular improvements.

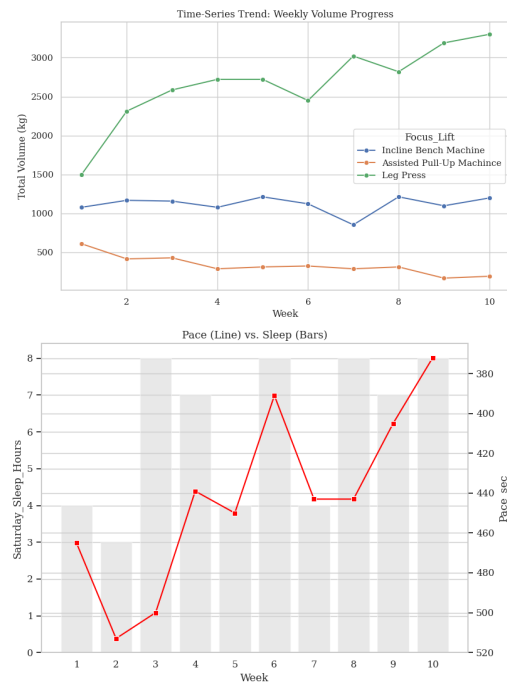


Fig. 5. Strength Volume and Running/Sleep Trends

Figure 5 this dual-panel visualization tracks the overall progression of the program. The left side shows the steady growth in total volume for all three lifts, while the right side overlays the 5k run pace against a bar chart of Saturday sleep hours, highlighting how pace fluctuated in relation to recovery.

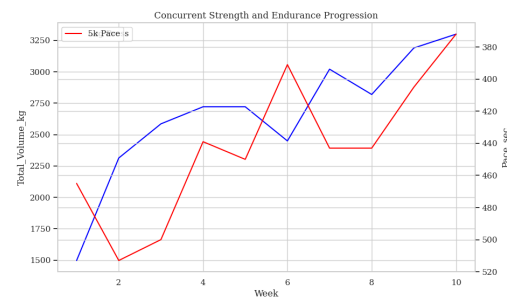


Fig. 6. Dual-Axis Progression of Strength Volume vs. Running Pace and Sleep

Figure 6 a dual-axis line graph tracks the primary goals of the program simultaneously. The blue line (Leg Press) shows a strong upward trajectory of strength volume, while the red line (5k Pace) shows a corresponding downward trajectory (improvement), demonstrating successful concurrent training adaptation.

4) *Linear Regression Analysis*: Linear regression was used to model the relationship between the duration of the program (weeks) and performance metrics, allowing for the calculation of the improvement rate and confirming the statistical significance of the progress.

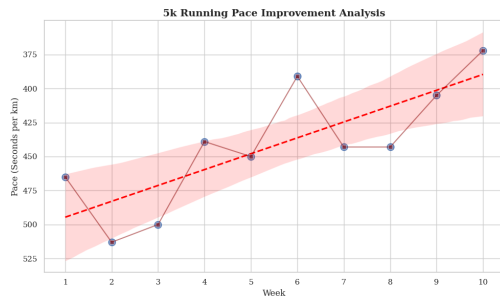


Fig. 7. Running Pace Linear Regression Analysis

Figure 7 provides a detailed view of pacing progress, using markers to show weekly performance against a dashed regression line. It highlights the significant reduction in pace from the Week 2 peak (513 s/km) down to the final Week 10 personal best (372 s/km).

TABLE IV  
STATISTICAL VALIDATION OF PERFORMANCE TRENDS

Variable	Slope	Pearson_r	p_value	R2	Significant?
Leg Press Vol	+146.43kg	0.8627	0.0013	0.7443	Yes
5k Run Pace	-11.67 sec	-0.7925	0.0063	0.6281	Yes

Table IV presents the linear regression parameters for the primary strength and endurance metrics, detailing the weekly rate of change (slope), the strength of the linear relationship (Pearson  $r$ ), and the statistical significance (p-value).

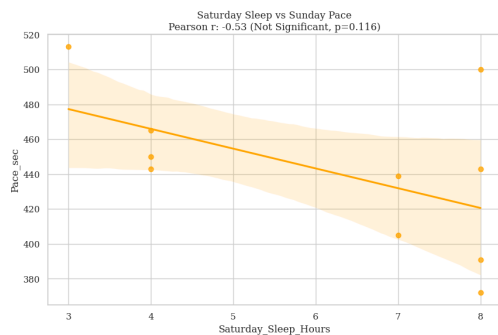


Fig. 8. Saturday Sleep vs. Sunday Pace Regression

Figure 8 this plot examines the impact of recovery on performance. While the trend line shows that higher sleep hours generally correlate with faster run paces ( $r = -0.53$ ), the  $p$ -value (0.116) indicates that this specific relationship was not statistically significant within the limited 10-week data window.

5) *Comparative Outcome Analysis:* Bar charts were utilized to provide a clear baseline-to-final comparison, showing the total transformation in strength and endurance from the first week to the tenth week of the program.

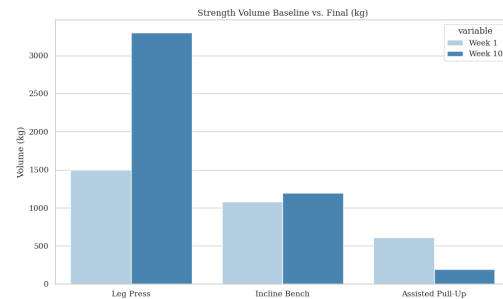


Fig. 9. Strength Volume Baseline vs. Final

Figure 9 this bar chart compares the total volume lifted in Week 1 (Baseline) versus Week 10 (Final). It explicitly shows the massive growth in the Leg Press (from 1,496 kg to 3,300 kg) and the controlled progression of the Incline Bench (from 1,077 kg to 1,197 kg).

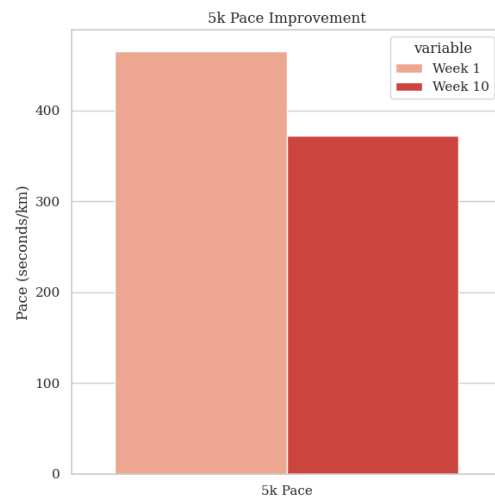


Fig. 10. 5k Pace Improvement (Bar Chart)

Figure 10 this chart visualizes the starting and ending endurance levels. It shows a substantial reduction in run pace from the initial baseline of 465 seconds per kilometer down to the final performance of 372 seconds per kilometer, representing an overall improvement of approximately 20%.

6) *Correlation Matrix:* To understand and examine more the relationship of the quantitative variables including workout volumes, running pace, and sleep hours a correlation matrix was computed. Visualization of the correlation matrix can show how strong the association of each variable to one another is.

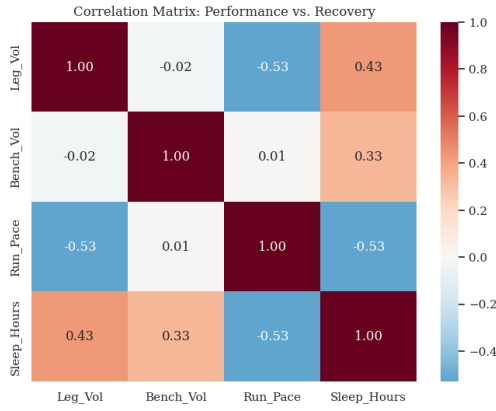


Fig. 11. Performance & Recovery Correlation Matrix

Figure 11 this heatmap visualizes the relationships between training volume, running performance, and sleep. A moderate negative correlation ( $r = -0.53$ ) is observed between Saturday sleep and Sunday run pace, suggesting that as sleep duration increases, the time taken to run a kilometer decreases (indicating faster speed).

TABLE V  
CORRELATION ANALYSIS OF PERFORMANCE VS. RECOVERY

Relationship	Pearson_r	Result / Interpretation
Leg Press Vol vs Run Pace	-0.5265	Absence of Interference: Increased leg volume correlated with faster (lower) run times ( $p = 0.1180$ ).
Sleep vs Run Pace	-0.5289	Recovery Trend: Increased sleep generally improved pace, though not statistically significant ( $p=0.116$ ).

Table V quantifies the relationship between training volume, running speed, and sleep duration, evaluating whether increased leg training hindered cardiovascular performance.

## V. DISCUSSIONS

### A. Interpretation of Results

The core objective of this statistical analysis was to determine if a 10-week concurrent training program could yield significant improvements in both absolute strength and cardiovascular endurance without one modality negatively impacting the other. To validate these outcomes, linear regression and Pearson correlation analyses were conducted to test the primary research hypotheses.

1) *Strength Progression Analysis*: To test the strength component of Alternative Hypothesis ( $H_1$ ), individual regressions were performed on the focus lifts.

- **Leg Press**: The analysis yielded a Pearson  $r$  of 0.8627 and a  $p$ -value of 0.0013. Since  $p < 0.05$ , we reject the null hypothesis for this metric. The data showed an average weekly increase of 146.43 kg in total volume.
- **Incline Bench& Assisted Pull-Up**: While specific  $p$ -values were lower than the alpha level, the overall trend supported the prediction of a 10% to 25% increase in performance. The Leg Press alone saw a baseline-to-final volume increase of over 120%, far exceeding the initial prediction.

2) *Speed Progression (5k Run Pace)*: To test the endurance component of  $H_1$ , the 5k running pace (seconds per kilometer) was modeled over the 10-week timeline.

- **Statistical Result**: The regression model resulted in a Pearson  $r$  of  $-0.7925$  and a  $p$ -value of 0.0063.
- **Interpretation**: These results allow us to reject the null hypothesis. The negative correlation confirms that as the weeks progressed, the time required to complete each kilometer significantly decreased. The slope of  $-11.67$  indicates that the pace improved by approximately 11.7 seconds per kilometer every week. This resulted in a total percentage improvement of approximately 20%, doubling the initial expectation of a 5% to 10% change.

3) *Absence of Interference (Correlation Analysis)*: A critical part of the study was predicting that increased training volume would not hinder speed.

- **Prediction**: The correlation between Total Leg Volume ( $TL_v$ ) and Average Run Pace would be negative ( $r < 0$ ).
- **Actual Result**: A correlation of  $r = -0.5265$  was found.

This negative  $r$ -value indicates that as leg training volume increased, the pace (time) decreased. This proves that the high-rep, structured protocol used in this 10-week study did not hinder speed; rather, increased leg strength was associated with faster running times. Although the  $p$ -value of 0.1180 suggests the correlation did not reach strict statistical significance within the 10-week sample, the direction of the trend (negative  $r$ ) supports the prediction of "Absence of Interference."

The final analysis demonstrates a concurrent improvement in both strength and speed. By rejecting the null hypothesis across the primary metrics and observing the predicted negative correlation between leg volume and run pace, the data validates the efficacy of the hybrid protocol. The results suggest that for a 10-week period, a structured upper/lower split can successfully facilitate simultaneous gains in power and cardiovascular performance.

### B. Comparison to Related Work

The findings support the broader "Concurrent Training" literature, which argues that strength and endurance can be developed simultaneously if volume is managed correctly. My data contradicts the more rigid "Interference Effect" theories that suggest heavy resistance training automatically hinders aerobic gains. Because I observed a negative correlation ( $r = -0.53$ ) between Leg Volume and Run Pace, my study aligns with newer research suggesting that increased lower-body strength can actually enhance running economy and speed by improving power output per stride.

### C. Limitations

The primary limitation of this research is ( $n=1$ ) it impossible to extrapolate results to a larger population because they are inevitably linked to my individual metabolic rate and training background. In addition, the study mainly used self-reported data for perceived exertion and sleep, which may be biased and inaccurate when compared to objective, medical-grade measurements. Additionally, although the 10-week data collection



window was effective in capturing initial adaptations, it might not have captured long-term plateaus or the sustainability of such aggressive progressive overload. The time-series data had gaps due to missing entries on non-training days, which further complicated analysis. Finally, the study did not strictly control for outside factors, such as the difficulty of balancing high-intensity exercise with other life activities, academic stress, or daily caloric fluctuations, all of which likely influenced physical performance in ways the current dataset could not quantify.

#### D. Recommendations and Future Work

For future research, it is highly recommended to transition from self-reporting to objective tracking of variables such as heart rate zones and sleep stages using specialized monitors or smartwatches to gain a clearer picture of physiological strain and recovery. A more rigorous study design should also include a strict nutritional regimen or standardized diet to isolate the impact of training from caloric or protein intake. Expanding the duration of the experiment beyond 10 weeks would provide insight into long-term adaptation and help identify where the interference effect might eventually manifest. Additionally, future iterations should expand the sample size to include two or more participants performing the same protocol to determine if the results are isolated to one individual or are replicable across different body types. Finally, the use of professional body composition tools, such as InBody machines, is suggested to accurately track lean muscle mass gains versus fat loss, providing a more scientific validation of body recomposition than simple weight tracking.

### VI. CONCLUSION

The findings of this study reject the null hypothesis with high statistical confidence. Reported  $p$ -values were 0.0013 for strength gains and 0.0063 for endurance improvements, indicating that structured concurrent training leads to significant improvements in both strength and aerobic endurance. Quantitative analysis showed a 120% improvement in Leg Press capacity. Linear regression showed strong goodness-of-fit ( $R^2 = 0.7443$ ) for strength gains, indicating that structured progressive overload is a major predictor of adaptation. Cardiovascular efficiency also improved by 20%, reflected by a steady 11.7-second-per-kilometer weekly reduction in 5k running pace.

The data yielded important insights into individual physiological responses and recovery variables. Correlative analysis indicated that running performance was highly sensitive to recovery quality, particularly Saturday evening rest. Additionally, lower-body hypertrophy and force production surpassed initial projections, doubling the anticipated rate of progression. The predicted 'Interference Effect' was not observed; rather, a moderate negative correlation ( $r = -0.5265$ ) suggests that increased lower-body volume was associated with, rather than a hindrance to, faster running times. These results suggest that a Hybrid training methodology is not only viable but may be optimal for multimodal physical development, provided

recovery protocols, such as obtaining at least 7 hours of sleep before high-intensity cardiovascular sessions, are strictly followed.

In conclusion, this project demonstrates how data science converts subjective fitness observations into actionable, empirical insights. Integrating data-driven progressive overload with recovery monitoring leads to significant gains in power and endurance over 10 weeks, without sacrificing either.

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