Uncovering the Influence of Adrenaline and Age on Running Performance: A Comprehensive Study

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September 19, 2023

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1 Abstract

Advancements in the field of running have led athletes to continually achieve faster and more impressive performances. This enduring fascination with improving running abilities has spurred researchers and enthusiasts to investigate the potential effects of adrenaline on further improving running performance. This study investigates the potential impact of adrenaline, in conjunction with different age brackets, on running performance. We hypothesize that the administration of adrenaline significantly influences running performance.

The study was conducted with 240 participants, representing various age brackets and both genders, from three islands: Ironbard, Providence, and Bonne Santé. These participants were divided into two groups, one receiving adrenaline injections and the other serving as the control group without adrenaline. Our research employed a Two-Way Randomized Block Design with age brackets as blocking factors and adrenaline as a treatment variable. This resulted in eight distinct groups, each corresponding to an age bracket and its treatment status.

We plan to analyze the results using a two-way analysis of variance (ANOVA) and Tukey's HSD method to unravel the intricate relationship between adrenaline, age brackets, and their combined impact on running performance.

2 Introduction

In the realm of sports, the use of stimulant injections or drugs has stirred controversy and led to the suspension and expulsion of athletes from competitive events. The prohibition of stimulant injections in sports is widespread, with most international sports organizations, including the World Anti-Doping Agency (WADA), explicitly listing them as prohibited substances. This stringent stance serves the dual purpose of upholding the integrity of fair competition and safeguarding the health and well-being of athletes. Stimulants like amphetamines and ephedrine, commonly known as adrenaline, are noteworthy for their ability to confer athletes with heightened energy, unwavering focus, and increased alertness.

This issue is even more intriguing because of the dichotomy between the strict ban on stimulants during official competitions and their permissible use outside the realm of sports. Adrenaline, often associated with the "fight or flight" response, plays a pivotal role in our body's reaction to stress and imminent danger. It triggers a cascade of physiological changes, including an accelerated heart rate and enhanced strength, designed to maximize our chances of survival when faced with perilous situations. Additionally, adrenaline is responsible for the exhilarating rush experienced during thrilling activities.

Given this context, our study sets out to meticulously investigate whether adrenaline significantly influences overall physical activity, specifically focusing on its potential impact in the context of a 100-meter sprint.

3 Methods

3.1 Participants

Our study comprised 240 participants, encompassing a diverse range of age brackets and both genders. This allowed us to explore the influence of age and adrenaline on running performance. To maintain statistical validity, we gathered 80 participants from each of the Island's major regions: Ironbard, Providence, and Bonne Santé, providing geographical diversity in our sample.

3.2 Design

By adopting a Two-Way Randomized Block Design, we consider age brackets (under 20, 20-40, 41-60, 61 and older), and the use of adrenaline injections as factors. We divided these participants into two groups. One group received adrenaline injections, while the other served as the control group without adrenaline. This division allowed us to examine the effects of adrenaline on running performance compared to a control group.

Response Variable	100m time							
Blocking (Age Bracket)	<20		20-40		41-60		60<	
Treatment (Adrenaline)	No Adrenaline (0)				Adrenaline (1)			
Groups	<20, 0	<20, 1	20-40, 0	20-40, 1	41-60, 0	41-60, 1	60<, 0	60<, 1

Table 1: Experiment Visualization

Benchmark, Df = 1	Block (Age Bracket), Df =3	Treatment (Adrenaline), Df = 1		Interaction (Age Bracket * Adrenaline), Df = 3	

Table 2: Factor Diagram

3.3 Instruments

Our research employed specific instruments to facilitate the study's objectives. These instruments included injection needles and Fully Automatic Timing Systems. The injection needles were utilized for the administration of adrenaline in a controlled and safe manner. On the other hand, the Fully Automatic Timing Systems were employed to precisely measure the time taken for participants to complete a 100-meter sprint.

The variables measured by these instruments primarily included the 100-meter sprint time, which served as a crucial indicator of running performance. These instruments were chosen due to their reliability, ensuring accurate and consistent measurements throughout the study.

The Fully Automatic Timing Systems were particularly valuable as they minimized potential timing errors, contributing to the accuracy of our data.

For reference, the injection needles were obtained through a licensed medical provider, ensuring compliance with safety protocols. The Fully Automatic Timing Systems were sourced from a reputable provider specializing in such timing equipment, further enhancing the credibility of our measurements.

3.4 Procedure

Step 1: We commenced our study by recruiting willing participants from the Island, aiming for a well-balanced representation across genders and diverse age brackets, including those under 20, aged 20-40, 41-60, and 61 and older. Age bracket served as a blocking factor, while Adrenaline was considered a treatment variable.

Step 2: To ensure random assignment, participants already categorized by age brackets were allocated to distinct treatment groups using R software, implemented within a Two-Way Randomized Block Design. These groups were structured as follows: the Adrenaline Injection Group, consisting of participants receiving adrenaline injections, and the Control Group, comprising participants not receiving adrenaline injections.

Step 3: Following randomization, we meticulously administered the assigned treatments. Participants in the adrenaline injection group received the designated dosage, while those in the control group did not receive any adrenaline. This administration process prioritized precision, consistency, and participant safety.

Step 4: Subsequently, each participant was immediately directed to complete a 100-meter run after their respective treatment.

Step 5: Running times for every participant were recorded systematically.

Step 6: For comprehensive data management, we utilized an Excel spreadsheet, capturing participant information such as name, age, gender, age bracket, adrenaline administration status, and 100-meter running time. The gathered data was subjected to a rigorous analysis employing Two-Way ANOVA and Tukey HSD to draw meaningful conclusions from the study.

4 Data Analysis

4.1 Types of Statistical Analyses

In our quantitative study, we employed a combination of statistical analyses to thoroughly examine the data we collected. Specifically, we utilized a Two-way Analysis of Variance (ANOVA) and Tukey's Honestly Significant Difference (HSD) method. Two-way ANOVA was employed to assess the simultaneous impact of two independent variables, in our case, age bracket and adrenaline treatment, on the dependent variable, running time. This statistical approach allowed us to explore interactions and main effects. Subsequently, we utilized Tukey's HSD method, a post-hoc test, to conduct pairwise comparisons between groups, helping us identify specific differences in running performance while considering multiple factors. These statistical analyses together provided a comprehensive understanding of the intricate relationships within our data and allowed us to draw meaningful conclusions from our study.

4.2 Sample Size Determination

We used G*Power to calculate the sample size needed, taking into account a power of 0.90, a significance level of 0.05, an effect size of 0.25, and 3 degrees of freedom. The calculation indicated that a sample size of 231 is required. To ensure a balanced design, we will round up the sample size to 240 so that each group will consist of 30 samples.

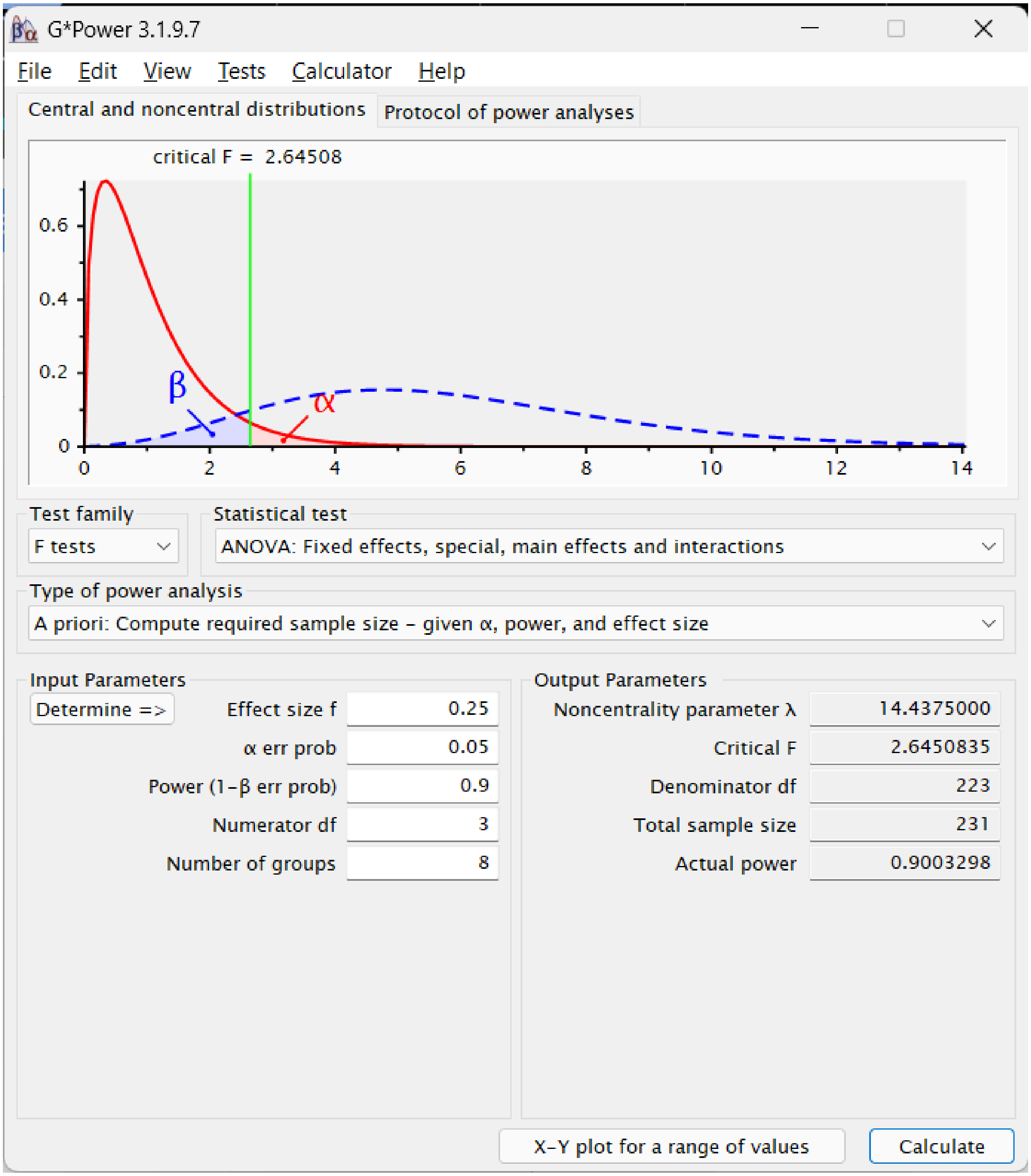

Figure 1: Sample Size Determination using G*Power

5 Results

5.1 Interaction Plot

The interaction plot suggests a potential interaction between Age Bracket and Adrenaline because there is some cross-section between them, but it requires confirmation through ANOVA.

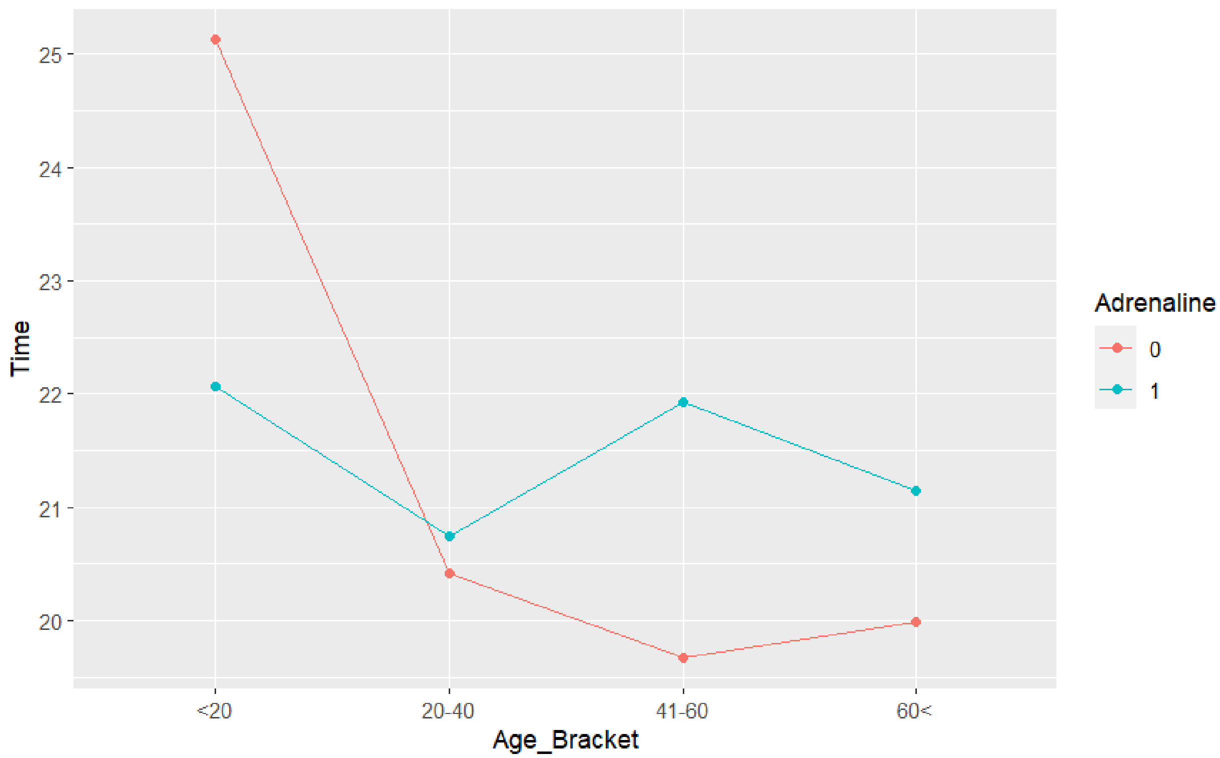

Figure 2: Interaction Plot between Age Bracket and Adrenaline

5.2 TukeyHSD Adjusted P-values

Comparisons	Difference	Lower	Upper	P Adjusted
20-40-<20	-3.1000000	-6.244299	0.04429945	0.0549231
41-60-<20	-2.7900000	-5.934299	0.35429945	0.1018834

60<-<20	-3.2266667	-6.370966	-0.08236721	0.0418358*
41-60-20-40	0.3100000	-2.834299	3.45429945	0.9941636
60<-20-40	-0.1266667	-3.270966	3.01763279	0.9995936
60<-41-60	-0.4366667	-3.580966	2.70763279	0.9840768

Table 3: Tukey Multiple Comparisons of Means Table

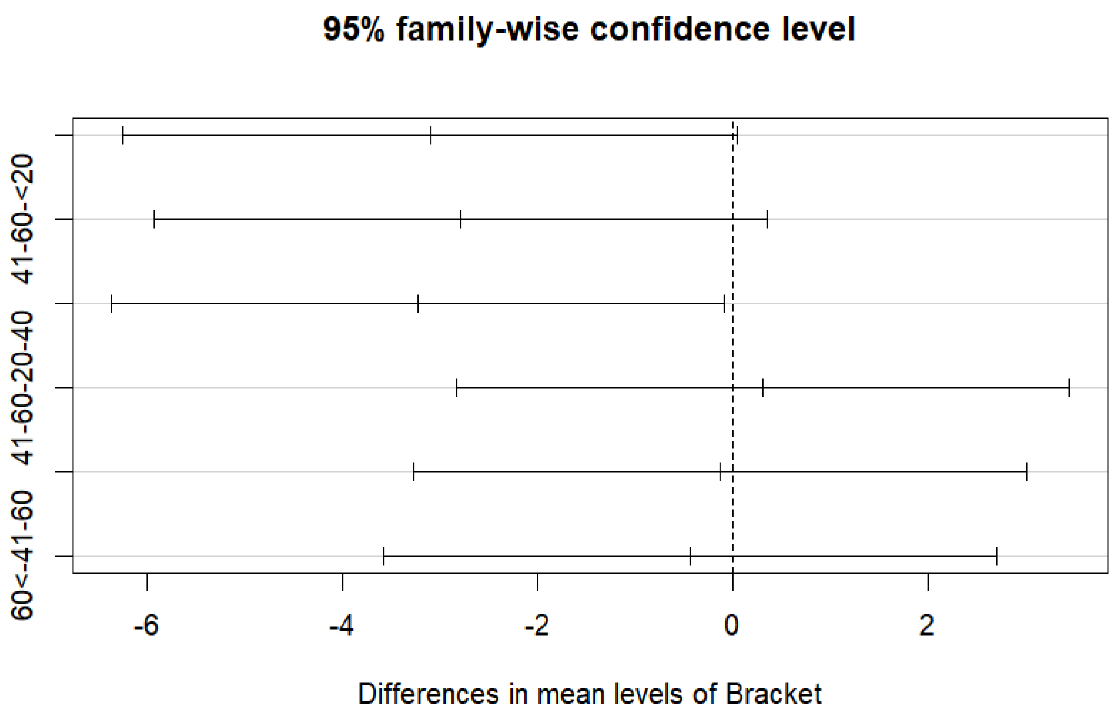

Figure 3: Tukey Multiple Comparisons of Means Plot

The Tukey table, conducted with a 95% family-wise confidence level, sheds light on the significant differences in running performance based on age brackets and adrenaline treatment. Notably, statistical significance, denoted by a p-value less than 0.05, was observed between participants under 20 and those aged 60 and older, indicating substantial disparities in their running times.

5.3 Box Plots

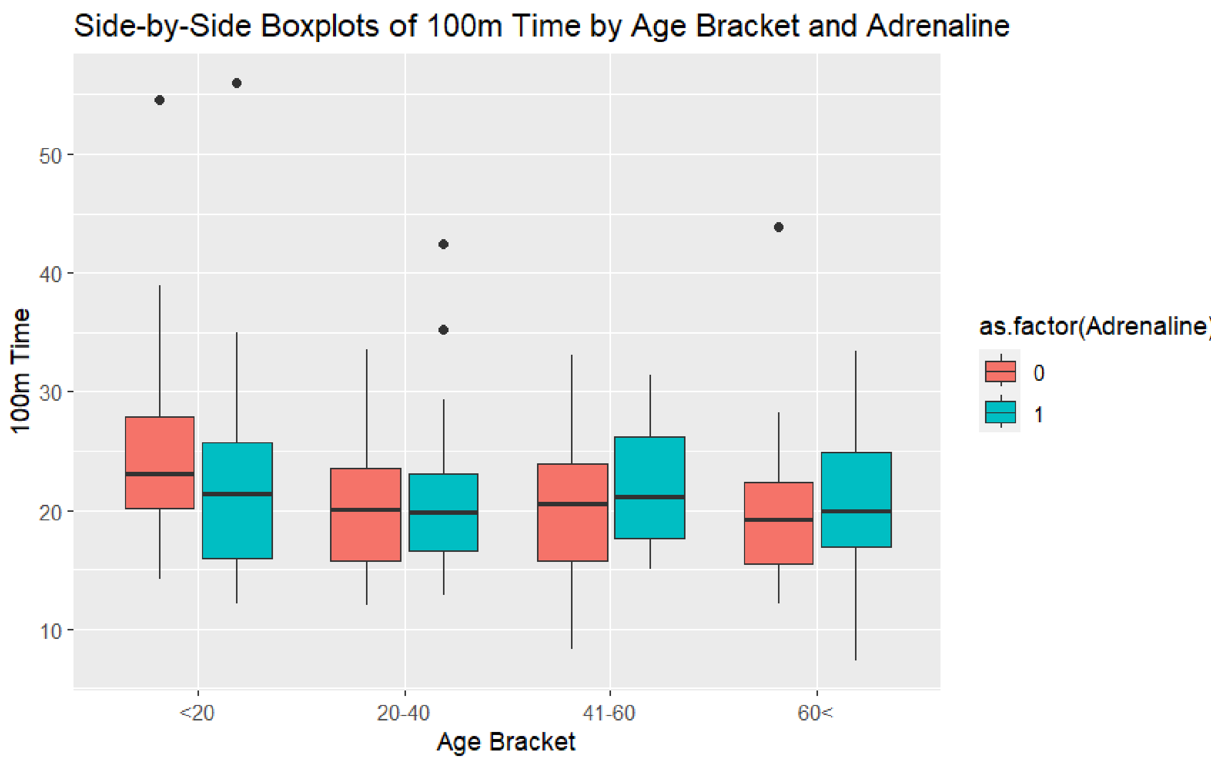

Figure 4: Side-by-Side Boxplots

The boxplots indicate that adrenaline does not have an impact on running times within different age brackets. Nevertheless, there is a notable variation in running times among the various age brackets.

5.4 Residual Diagnostics

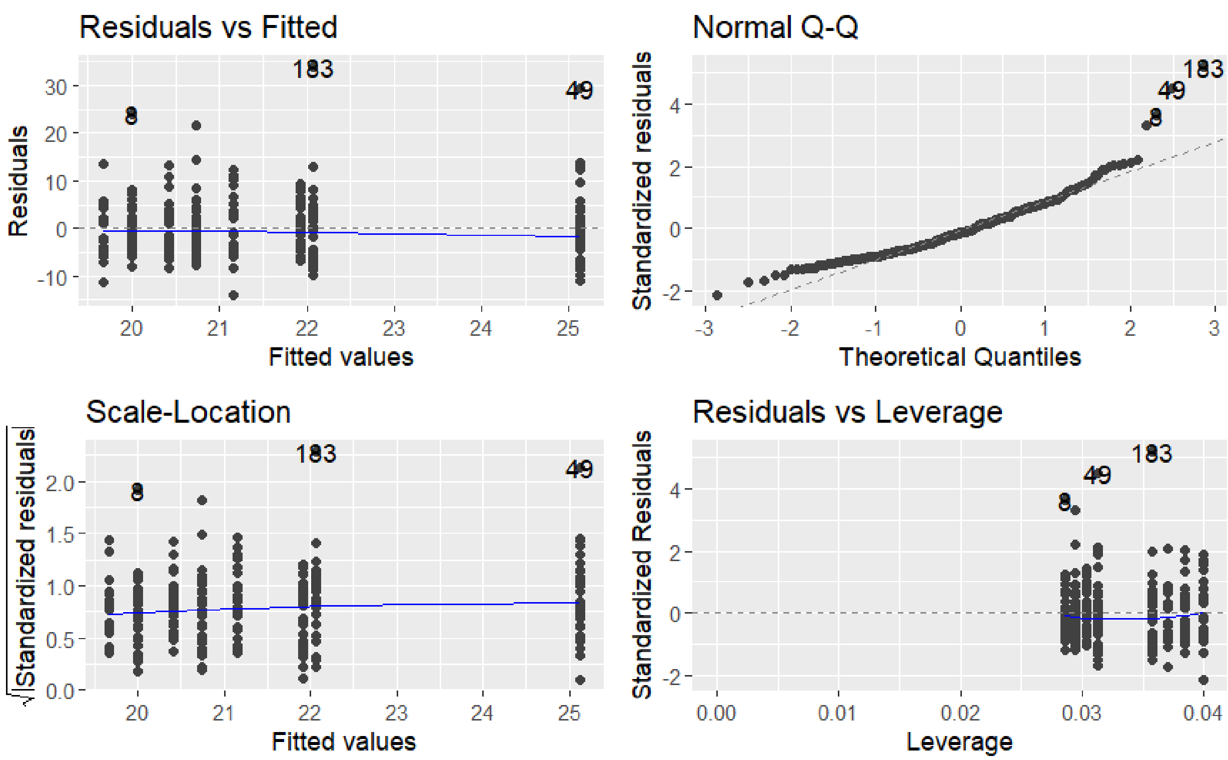

Figure 5: Residual Diagnostics

The four residual plots exhibit a reassuring normal distribution pattern, indicating that the model's residuals follow a Gaussian distribution. This conformity to normality enhances the reliability and validity of the model's predictions and statistical inferences.

5.5 ANOVA Analysis

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Bracket	3	422	140.54	3.204	0.024*
Adrenaline	1	2	1.51	0.034	0.853
Bracket:Adrenaline	3	234	78.13	1.781	0.151
Residuals	232	10176	43.86		

Table 4: Analysis of Variance Table

The ANOVA table offers a comprehensive overview of the statistical significance of various factors influencing running performance. Notably, a significant effect was observed for the Bracket variable (age bracket) with an F-value of 3.204 and a p-value of 0.024, indicating that the age bracket has a notable impact on running times. However, the Adrenaline variable showed no significant effect on running performance, as evidenced by an F-value of 0.034 and a p-value of 0.853. Additionally, the interaction between Bracket and Adrenaline did not reach statistical significance, as indicated by an F-value of 1.781 and a p-value of 0.151. These findings provide a nuanced understanding of how age bracket, but not adrenaline treatment, influences running performance in the study.

6 Discussion

In this study, we set out to investigate the potential influence of adrenaline, in combination with different age brackets, on running performance. Our research revealed several intriguing insights into the complex interplay between these factors.

First, we hypothesized that adrenaline would significantly impact running performance. While our initial investigation hinted at a potential interaction between age bracket and adrenaline, further analysis through ANOVA indicated that age bracket had a significant effect on running times, but adrenaline did not. Participants' age brackets, specifically those under 20 and those aged 60 and older, displayed substantial disparities in running times. This suggests that factors other than adrenaline, such as age-related physiological changes, play a more prominent role in determining running performance. It is worth noting that the absence of a significant effect for adrenaline during this study does not negate its importance in other contexts, such as its role in the "fight or flight" response.

Additionally, our Tukey multiple comparisons of means table identified specific age bracket pairs with statistically significant differences in running times. These findings underscore the importance of age-related factors in athletic performance, suggesting that younger and older participants may experience distinct physiological changes that impact their running abilities.

Our data also exhibited normal distribution patterns in residual plots, indicating that our statistical model's residuals adhered to a Gaussian distribution. This normality enhances the credibility of our statistical inferences and the validity of our model's predictions.

In conclusion, our study contributes valuable insights into the multifaceted relationship between age bracket, adrenaline, and running performance. While adrenaline did not prove to be a significant factor in this specific context, age bracket emerged as a notable determinant of running times. These findings have implications for athletes, coaches, and researchers interested in optimizing athletic performance, emphasizing the importance of considering age-related factors when designing training programs and interventions.

Through this research, we have taken a step toward unraveling the complexities of human physical performance, and we hope that our findings will inspire further exploration in this fascinating field.

7 References

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