

Strong-D: Heart Rate EDA

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Outline

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Strong-D Study

Strength Training Regimen for Normal Weight Diabetics

- ▶ Goal: determine the best exercise regimen for normal weight participants with Type 2 Diabetes
 - ▶ Manipulated variables: strength vs aerobic vs combined exercises
 - ▶ Response variable: blood sugar levels
- ▶ Data:
 - ▶ Fitbit: frequent measurements, e.g. per second raw heart rate
 - ▶ iPad sign-in data, e.g. study arm data
 - ▶ Clinical + demographics data, e.g. weight, race

Participants

Participant Demographics by Randomization Arm Racial Category & Gender

	ARM 1 (Strength)	ARM 2 (Aerobic)	ARM 3 (Combination)
Race			
White/Caucasian	4	6	4
Asian	36	33	39
Black/ African American	1	3	1
Other	3	0	0
Unknown	1	2	0
Gender			
Male	26	23	30
Female	19	21	14
Total	45	44	44

Figure 1: Participant demographics by study arm.

source: <https://osf.io/ku56d/>

Background: Diabetes

- ▶ Elevated levels of blood glucose (hyperglycemia)
- ▶ Insulin signals cells to absorb glucose from the blood
- ▶ Type 1 diabetes: impaired insulin production
- ▶ **Type 2 diabetes:** insulin resistance
- ▶ Lifestyle interventions, e.g. exercise

Background: Resting Heart Rate (RHR) and Fitness

- ▶ “a higher average number of steps per day is associated with lower resting HR”
 - ▶ Li X, Dunn J, Salins D, Zhou G, Zhou W, Schüssler-Fiorenza Rose SM, et al. Digital Health: Tracking Physiomes and Activity Using Wearable Biosensors Reveals Useful Health-Related Information. PLoS Biol. 2017;15(1):e2001402.
- ▶ “meta-analysis indicates a strong positive association between high resting heart rate and the risk of type 2 diabetes”
 - ▶ Aune D, ó Hartaigh B, Vatten LJ. Resting heart rate and the risk of type 2 diabetes: A systematic review and dose-response meta-analysis of cohort studies. Nutrition, Metabolism and Cardiovascular Diseases. 2015 Jun 1;25(6):526–34.

Want: Decreasing RHR over the course of the study.

Big Ideas Lab Hypothesis

Current Hypothesis: How does Resting Heart Rate (RHR) change over time?

- ▶ Correlation with fitness level (to be investigated)
- ▶ Compare across study arms

How does Resting Heart Rate (RHR) change over time?

Data Preprocessing

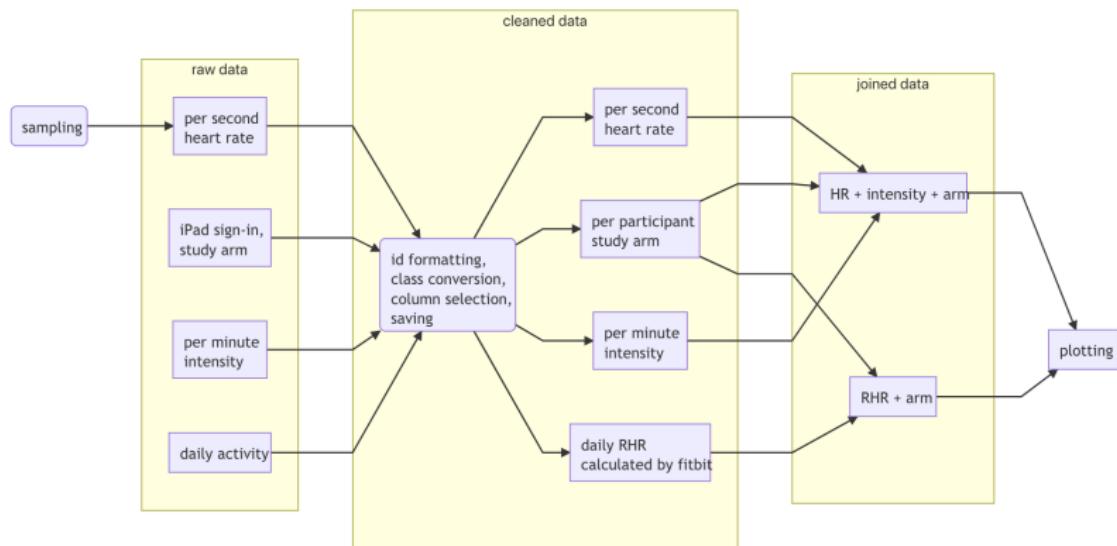


Figure 2: Data preprocessing flowchart.

EDA: Resting Heart Rate, Time, Exercise Intensity Level

How do we *define* RHR?

1. Fitbit's calculation of RHR
2. Raw (per second) heart rate values at sedentary intensity level
 - ▶ 0: sedentary, 1: light, 2: moderate, 3: very active
 - ▶ Intensity levels are calculated by Fitbit

Limitations of these definitions?

To be investigated:

- ▶ Raw heart rate values during time periods with infrequent steps

Proposed RHR Definition 1: Fitbit's Calculation

Def 1: RHR per Day per Study Arm

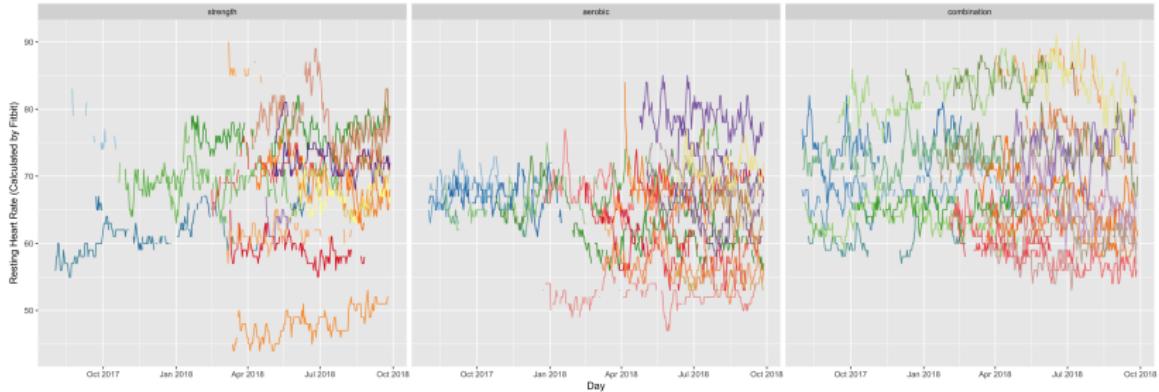


Figure 3: RHR (calculated by Fitbit) per day, faceted by study arm.

- ▶ Each color represents a different participant (79)
 - ▶ Better use of colors?
- ▶ **Limitation: missing values**

Def 1: Median RHR per Day per Study Arm

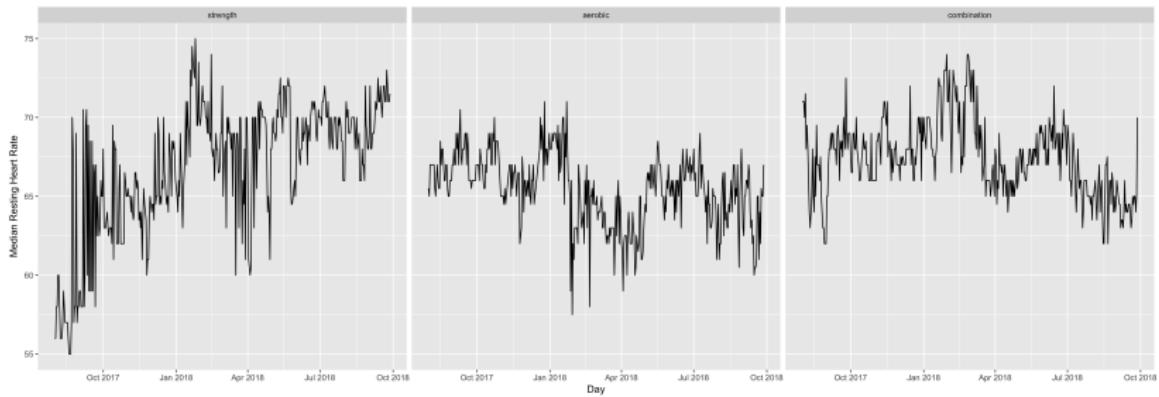


Figure 4: Median RHR per day, faceted by study arm.

- ▶ Median line for each study arm plot from the previous slide
- ▶ Trend does not suggest decreasing RHR

Proposed Definition 2: Raw (per second) heart rate values at sedentary intensity level

Def 2: Heart Rate per Intensity Level

- Advantage: raw per second HR data has no missing values!

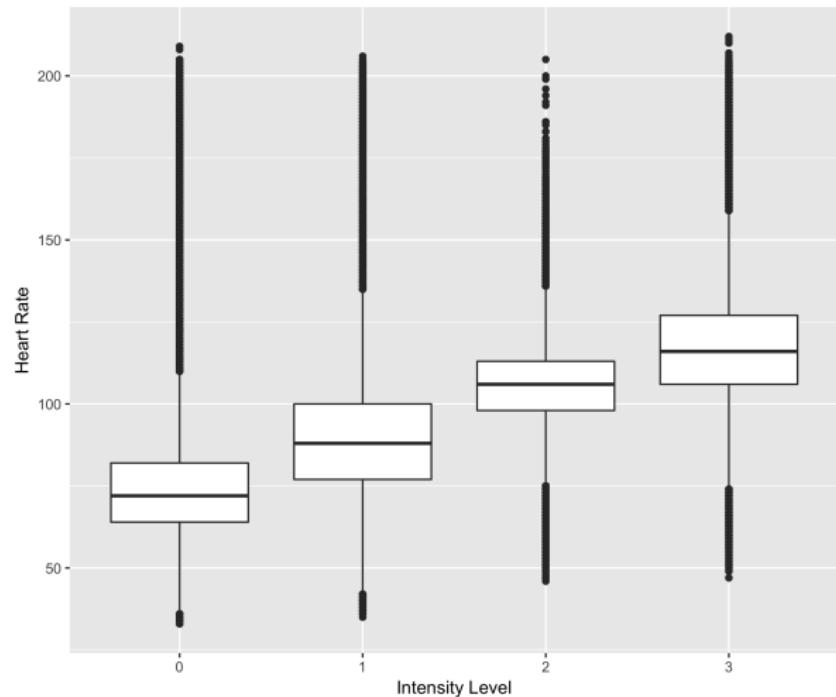


Figure 5: HR per intensity level.

Def 2: Heart Rate per Intensity Level per Study Arm

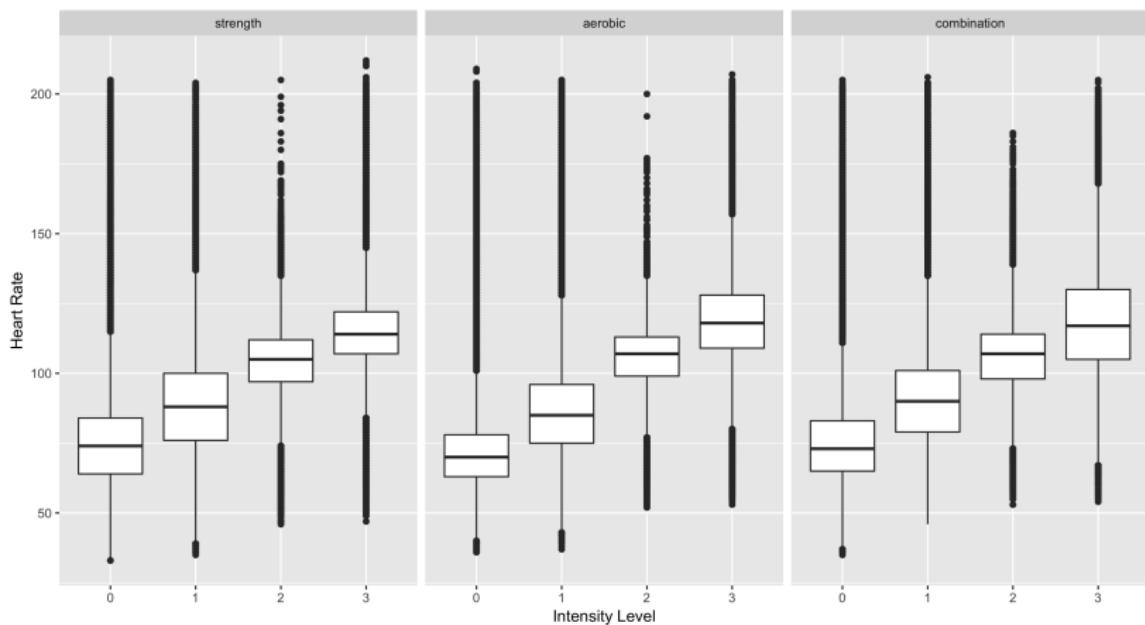


Figure 6: HR per intensity level, faceted by study arm.

- ▶ Outliers (absolute distance $> 1.5 * IQR$ from the 1st or 3rd quartile)

Def 2: RHR per Second per Study Arm

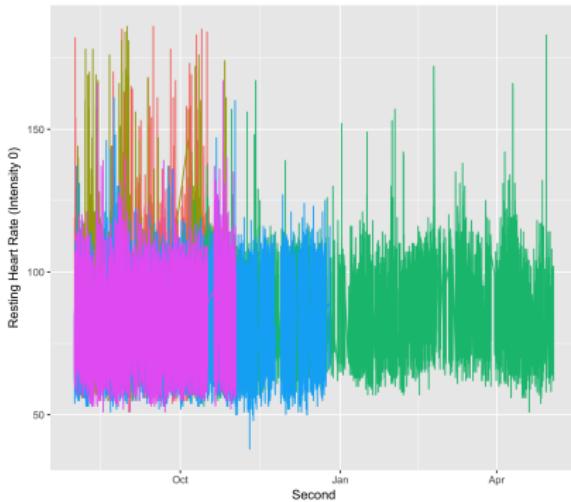


Figure 7: RHR (sedentary intensity) per second for a few participants, faceted by study arm.

- ▶ Limitations:
 - ▶ Noise
 - ▶ Not possible to plot all participants
- ▶ Aggregation

Def 2: Minimum RHR per Day per Study Arm

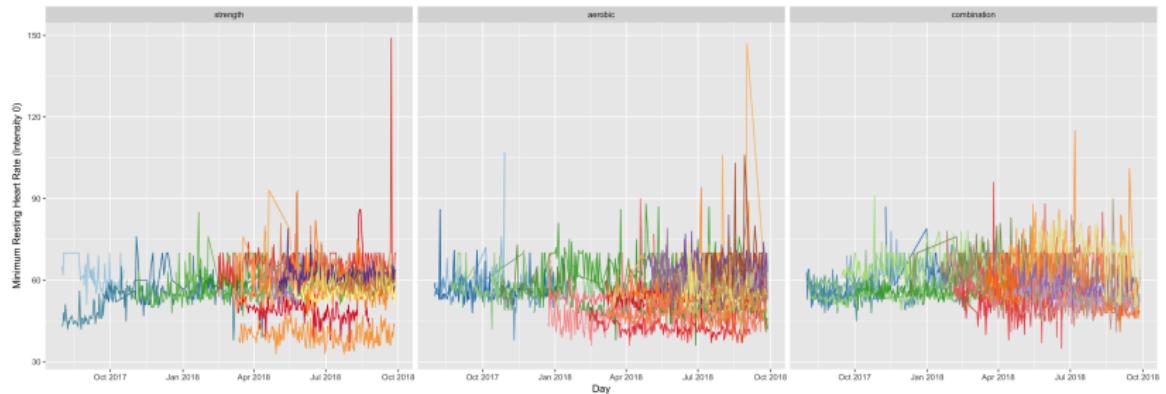


Figure 8: Min. RHR (sedentary intensity) per day, faceted by study arm.

- ▶ Minimum could be an outlier

Def 2: Lower Quartile RHR per Day per Study Arm

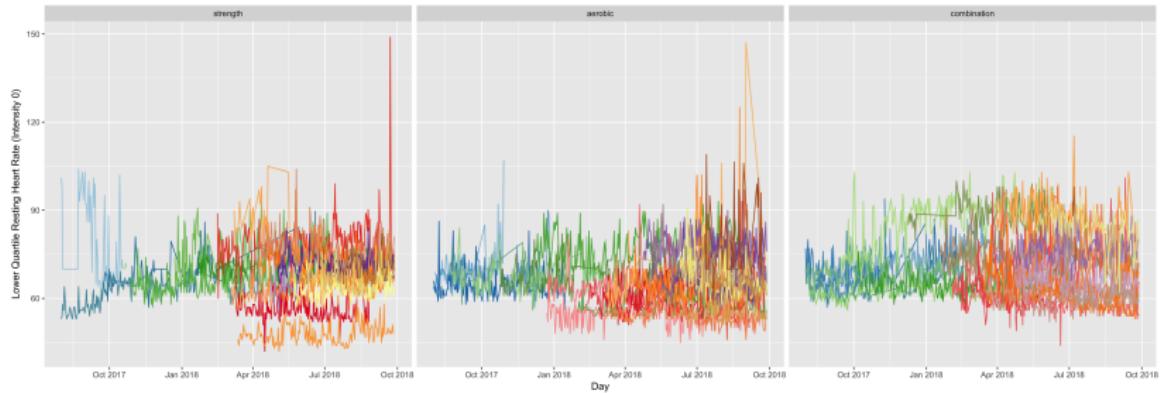


Figure 9: Lower quartile RHR (sedentary intensity) per day, faceted by study arm.

- ▶ Outliers
- ▶ No decreasing trend

Def 2: Limitations

- ▶ Outliers
- ▶ Intensity levels are calculated by Fitbit
 - ▶ Proprietary algorithm
 - ▶ Possibly calculated with HR values -> what does it mean to relate intensity and HR?

Next Steps

Address Limitations

- ▶ Fitbit calculations
- ▶ Outlier removal
- ▶ Revise RHR definition
 - ▶ Raw heart rate values during time periods with infrequent steps

Fitness Level

- ▶ Correlation between RHR and fitness level