THE EFFECTS OF EXERCISE ON STRESS

Group 15: Isabelle, Jackelin, Katelyn, Mingye, Ngoc, & Sam

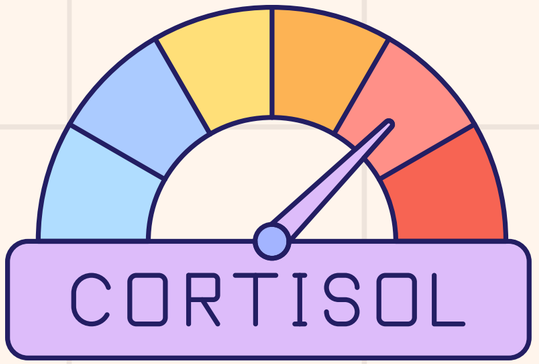
INTRODUCTION

Growing research has suggested the role of physical activity in mental health, particularly in managing stress (American Psychological Association, 2020).

In this project, we aim to design an experiment that explains how varying exercise intensity affects salivary cortisol (stress) levels using ‘The Islands’ virtual simulation. Many students experience stress on a regular basis so we wanted to see if we could produce statistical evidence to support a causal relationship.

RESEARCH QUESTION:

What type of exercise is the most effective at reducing cortisol (stress levels)?



Expectation: We expect low to moderate intensity exercises to reduce stress levels the most.

POPULATION OF INTEREST:

Men and women ages 12 and up who can exercise and could provide salivary cortisol for analysis.

OUR APPROACH

1. Randomly sample participants aged 12+
2. Measure participants' baseline (day 0) salivary cortisol levels and measure cortisol levels before and after exercising
3. ANOVA test
4. Post Hoc test
5. Check model assumptions
6. Power test
7. Fit final population model
8. Discuss results and limitations

DESIGN OF THE EXPERIMENT

RANDOMIZED COMPLETE BLOCK DESIGN

6 levels for the treatment factor:

- Yoga
- Freestyle swimming
- Strength training
- Running outdoors
- Brisk walking outdoors
- Doing nothing (control group)

We also blocked the participants by age into 6 categories:

- 12-19 y/o
- 20-29 y/o
- 30-39 y/o
- 40-49 y/o
- 50-59 y/o
- 60-99 y/o

Because energy and stress levels change as people age, this aims to reduce the variability of the effect of age on the treatment.

RANDOM SAMPLING

- We sampled a total of 90 islanders, 30 selected from each island.
- **90 replicates (6 x 15), 180 obs.(before and after)**
- We used R to randomly sample cities within each island with replacement. Then we randomly sampled the houses without replacement to avoid confounding variables such as housing situation.
- If a person refused to be a participant in the study, withdrew, or passed away, we resampled from houses in the same city to find a replacement.

RANDOM SAMPLING CODE SNIPPIT:

Ironbard: 30 people

```
> sample(1:6, 30, replace = TRUE)
 [1] 5 3 2 1 5 2 1 4 5 3 6 3 6 2 4 2 5 3 3 2 2 1 6 4 1 1 5 2 1 3
```

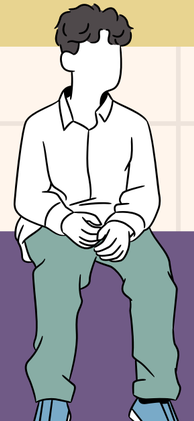
Vardo:

Houses: 423, 728, 355, 721, 447, 302

```
> sample(1:747, 6)
[1] 423 728 355 721 447 302
```

ASSIGNING TREATMENTS

For each island, we used a random number generator to assign a number to each participant then sorted them randomly based on this number. We then listed the treatments and used R to randomly generate a treatment order. Every five participants were assigned the treatment based on that order.



RESULTS AND INTERPRETATION

ANOVA RESULTS:

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	5	0.00584	0.0011677	1.855	0.112
age	7	0.00504	0.0007193	1.142	0.346
Residuals	77	0.04848	0.0006296		

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	5	0.00584	0.0011677	1.823	0.117
gender	1	0.00034	0.0003366	0.525	0.471
Residuals	83	0.05318	0.0006407		

- Our ANOVA model shows that the exercises are not significant in having an effect on the islanders' cortisol levels, for the p-value is greater than 0.05.
- We tried blocking by age and gender separately. **Age** gives a smaller p-value than gender.
- We can conclude that there is **no statistically significant difference** in cortisol level changes among different exercises, with the **blocking** of age.

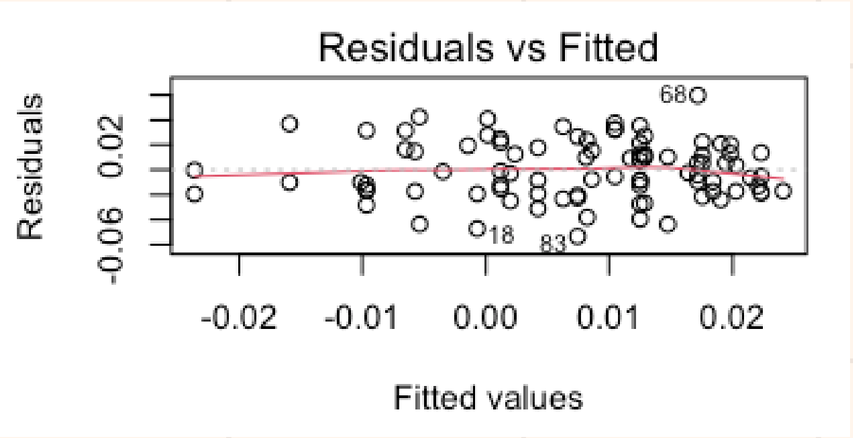
POST-HOC ANALYSIS

Tukey's HSD

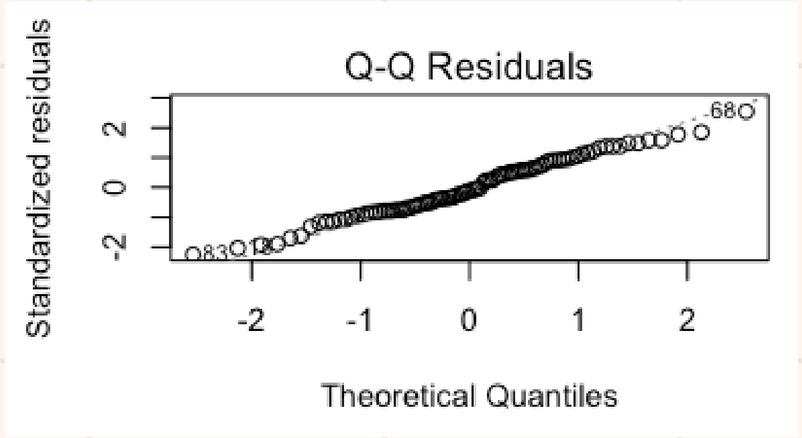
```
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = change ~ treatment + age)

$treatment
                         diff         lwr         upr     p adj
run-nothing       -0.0216666667 -0.04844560 0.005112268 0.1817873
strength-nothing  -0.0207333333 -0.04751227 0.006045601 0.2220583
swim-nothing      -0.0199333333 -0.04671227 0.006845601 0.2611173
walk-nothing      -0.0243333333 -0.05111227 0.002445601 0.0964242
yoga-nothing      -0.0155333333 -0.04231227 0.011245601 0.5390478
strength-run       0.0009333333 -0.02584560 0.027712268 0.9999984
swim-run           0.0017333333 -0.02504560 0.028512268 0.9999652
walk-run          -0.0026666667 -0.02944560 0.024112268 0.9997082
yoga-run           0.0061333333 -0.02064560 0.032912268 0.9847734
swim-strength      0.0008000000 -0.02597893 0.027578934 0.9999993
walk-strength     -0.0036000000 -0.03037893 0.023178934 0.9987437
yoga-strength      0.0052000000 -0.02157893 0.031978934 0.9928319
walk-swim         -0.0044000000 -0.03117893 0.022378934 0.9967222
yoga-swim          0.0044000000 -0.02237893 0.031178934 0.9967222
yoga-walk          0.0088000000 -0.01797893 0.035578934 0.9288829
```

- We used **Tukey's Method** to narrow down whether there could be an exercise contributing to lower cortisol levels.
- The result shows that **walk-nothing** has the lowest p-value of 0.096. **Walking** can potentially be significantly different compared to doing nothing.

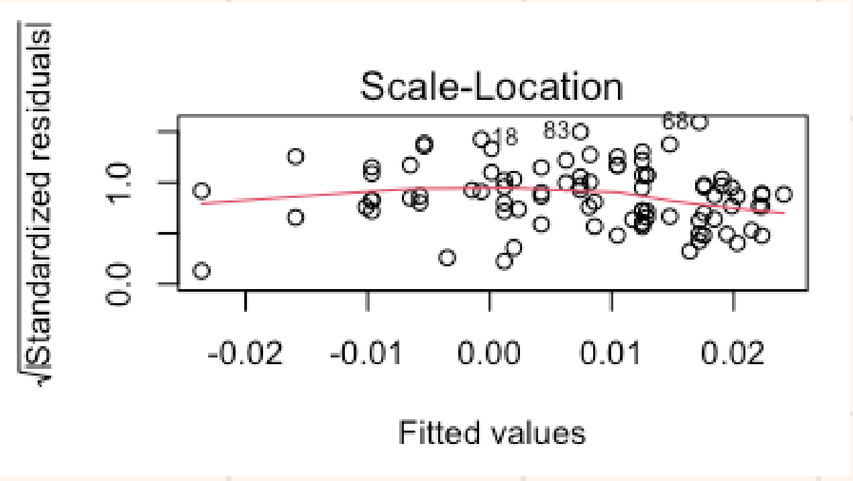
MODEL ASSUMPTIONS:



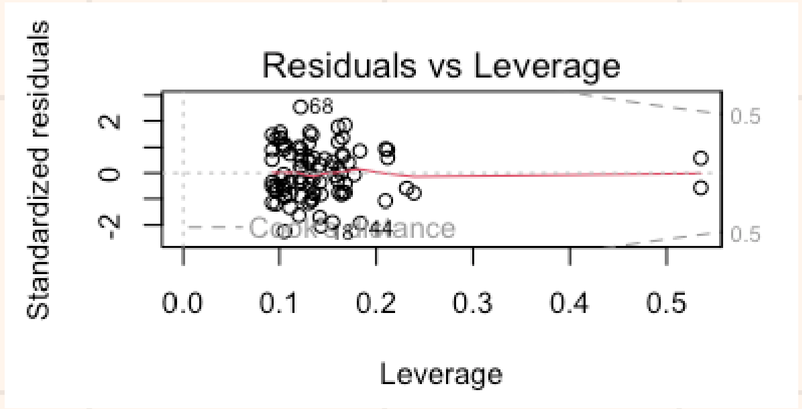
HOMOSCEDASTICITY AND LINEARITY IS SATISFIED.



NORMALITY OF THE ERROR TERM IS SATISFIED.



HOMOSCEDASTICITY IS SATISFIED.



VERY FEW INFLUENTIAL / LEVERAGE POINTS

POWER ANOVA RESULTS:

GROUP MEANS (DIFFERENCE IN CORTISOL):

BRISK WALK OUTDOORS: 0.014733333

NOTHING (CONTROL): -0.009600000

RUN OUTDOORS: 0.012066667

STRENGTH TRAINING: 0.011133333

SWIM FREESTYLE: 0.010333333

YOGA: 0.005933333

WITHIN STANDARD DEVUATION: 0.02524062

The group means and within standard deviation was used to calcluate the f-value for the power anova test.

K = 6

N = 27.89473

F = 0.3191055

SIG.LEVEL = 0.05

POWER = 0.9

The particpants per group was larger than we expected. Due to time constraints we were only able to include 15 per group instead of 28 (28 x 6 = 168).

DISCUSSION

TAKEAWAY: WALKING & CORTISOL

Despite not finding statistically significant differences between exercises groups due to variation within the blocks, walking showed the most promising results for reducing cortisol levels in comparison to doing nothing, especially among different age groups.

This aligns with the article, **"The relationship between exercise and cortisol: A review of findings and future directions" (Zschucke et al., 2021),** which also used a randomized block design and salivary cortisol to determine what type of exercise, based on intensity, reduced stress levels. The experiment found that low-moderate intensity exercise, like walking, often resulted in reduced cortisol. They also discussed the importance of controlling confounding variables, like fitness baseline and recent stress exposure, that can lead to variability with the blocks. These were variables we were not able to control in our experiment, potentially explaining our results.

LIMITATIONS

What could be affecting our results?

- **Simulated data** – may not reflect real-world complexity and natural physiological variation in participants.
- **Uncontrolled variables** - factors like diet, sleep, and time of cortisol collection can cause a lot of within-group variation.
- **Small sample size** – Our sample size may not be big enough to detect small effects between groups.

THANK YOU FOR YOUR ATTENTION