Investigating

THE IMPACT OF SWIMMING DISTANCE AND WATER INTAKE AMOUNT ON BLOOD GLUCOSE LEVELS

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Experiment Background and Setup

Research Question

How does the distance of swimming and the amount of water consumed affect **blood glucose level?**

Design

2^2

Factorial Design

(2 replicates for each treatment combination)

Treatment factors

Swimming Distance (A)		Water Consumed (B)	
1500m	HIGH	250ml	HIGH
200m	LOW	60ml	LOW

1 block with 4 levels

Age Groups

<20	21- 40
41- 60	>60

Response variable

Change in blood glucose levels (mg/dL)

Blood glucose levels were measured before and 30 min after the swimming sessions and hydration.

What is blood glucose?

The measurement of the amount of sugar in one's blood; the body's primary source of energy

What affects blood glucose?

- *Physical activity*
- *Food consumption*
- *Hydration*
- *Stress*

Why is it important?

We want to investigate how physical activity and hydration affect one's blood glucose level and make relevant suggestions accordingly.

Experiment Design Visualization

- a = 2 (swimming)
- b = 2 (drinking water)
- Number of block levels = 4
- n = 2 (two replicates)

→

N = 4*abn
= 4*2*2*2
= 32

→ **32 Total runs**

	0 - 20				21 - 40				41 - 60				61+			
	60 mL		250 mL		60 mL		250 mL		60 mL		250 mL		60 mL		250 mL	
200 m	-5	-1	-1	1	-3	0	4	0	-3	1	-1	1	-2	0	1	-2
1500 m	-1	-1	0	-4	-3	5	-1	-3	-2	-3	1	-1	0	3	0	-3

Understanding the Data Source

Selection Process

1. Randomly chose Vardo as the only island we sampled from

   Sampling in one place helps maintain consistency and reduces variability in data collection, making it easier to control for external factors that might influence the results.

2. Choosing Random Houses

   We used the runif() function in R to generate 32 random numbers out of 595 (each number represents a household).

3. Selecting survey participants

   We asked for consent from all members of each household, and randomly grouped the members who consented into 4 different age groups (<=20, 21-40, 41-60, >=61) and randomly assigned the treatments to participants within each block.

Participant Profile

8 0-20 years old

8 21-40 years old

8 41-60 years old

8 61+ years old

Data Analysis

Raw Data

Name	Age	Age Blocks	House Number	Swim Distance (meters)	Swim Level	Water Consumption (mL)	Water Consumption Level	Glucose Before (mg/dL)	Glucose after (mg/dL)	Difference
Emma Solberg	15	0-20	222	1500	1	250	1	90	90	0
Ajay Datta	16	0-20	159	1500	1	250	1	93	89	-4
Karl Meyer	6	0-20	297	200	-1	250	1	89	88	-1
Hannah Yamada	8	0-20	239	200	-1	250	1	88	89	1
Oceane Kimura	9	0-20	393	1500	1	60	-1	89	88	-1
Olson Solberg	11	0-20	222	1500	1	60	-1	93	92	-1
Emma Blomgren	13	0-20	38	200	-1	60	-1	94	89	-5
Torvald Sorensen	14	0-20	458	200	-1	60	-1	97	96	-1
Pernille Blomgren	28	21-40	50	1500	1	250	1	91	90	-1
Erling Carlsen	30	21-40	50	1500	1	250	1	88	85	-3
Owen Moore	31	21-40	38	200	-1	250	1	80	84	4
Devak Gadhavi	32	21-40	123	200	-1	250	1	96	96	0
Michelle Kimura	22	21-40	57	1500	1	60	-1	95	92	-3
Hiro Kimura	35	21-40	222	1500	1	60	-1	88	93	5
Gerik Sorensen	24	21-40	229	200	-1	60	-1	94	91	-3
Richard Meyer	26	21-40	297	200	-1	60	-1	88	88	0
Manan Babu	45	41-60	9	1500	1	250	1	86	87	1
Rhea Lingutla	58	41-60	287	1500	1	250	1	89	88	-1
Goetz Lutz	47	41-60	115	200	-1	250	1	85	86	1
Tineka Thorn	48	41-60	119	200	-1	250	1	89	88	-1
Suvarna Varma	45	41-60	357	1500	1	60	-1	93	91	-2
Marcel Thorn	49	41-60	119	1500	1	60	-1	93	90	-3
Jarrod Hall	50	41-60	326	200	-1	60	-1	95	92	-3
Nikola Ludwig	59	41-60	175	200	-1	60	-1	95	96	1
Herve Georges	61	61+	483	1500	1	250	1	94	94	0
Dr Sara Wallace	61	61+	483	1500	1	250	1	95	92	-3
Yorick Lund	63	61+	584	200	-1	250	1	92	93	1
Juhani Thorn	105	61+	228	200	-1	250	1	92	90	-2
Dieter Franke	65	61+	575	1500	1	60	-1	91	91	0
Torvald Eklund	74	61+	203	1500	1	60	-1	96	99	3
Kamal Gadhavi	80	61+	535	200	-1	60	-1	90	88	-2
Dennis Grimm	85	61+	45	200	-1	60	-1	91	91	0

Initial Observations:

-0.78

Average glucose level change

41.9

Average age

Data Analysis

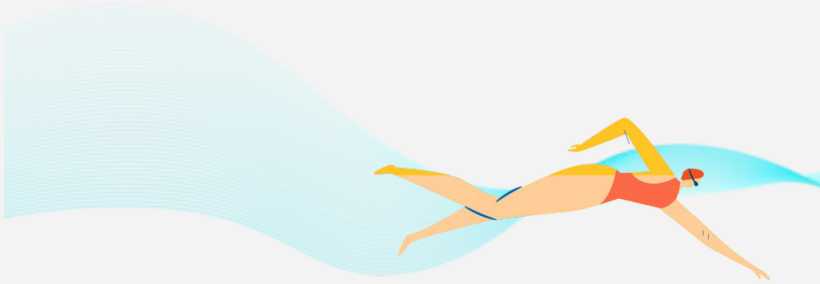
Reading in Data

```
> data1 <- read.csv("swim_water_data.csv")
> blood_glucose_change <- data1$Difference
> swim <- data1$Swim.Level
> water <- data1$Water.Consumption.Level
> block <- data1$Age.Blocks
```

Creating Anova Table

```
> model1 <- aov(blood_glucose_change ~ factor(swim)*factor(water)+factor(block))
> summary(model1)

                          Df Sum Sq Mean Sq F value Pr(>F)
factor(swim)               1   0.28   0.281   0.058 0.8124
factor(water)              1   1.53   1.531   0.313 0.5808
factor(block)              3   8.84   2.948   0.603 0.6193
factor(swim):factor(water) 1  19.53  19.531   3.993 0.0567 .
Residuals                 25 122.28   4.891
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```



Analysis and Interpretation

Anova Table

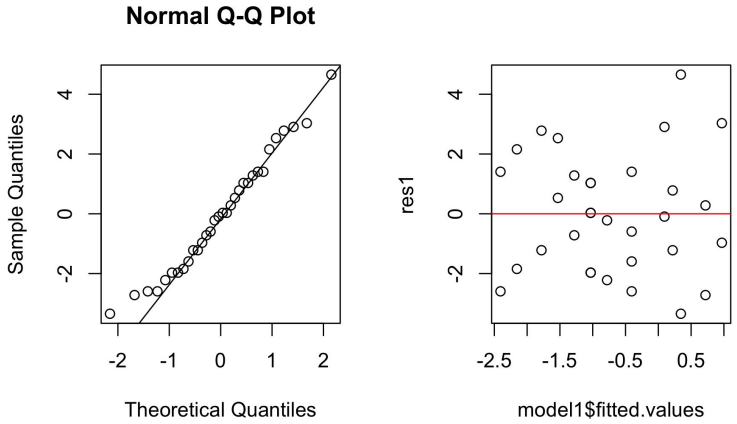
None of the main effects (swim, water) are individually significant.

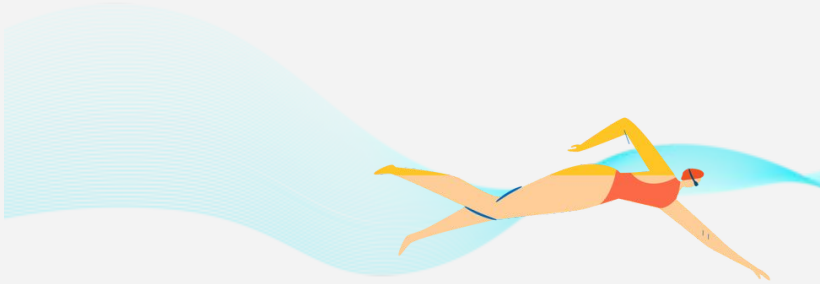
The interaction between swim and water shows a marginal significance, suggesting a possible combined effect on blood_glucose_change that warrants further investigation.

Data Analysis

Residuals Analysis

```
> par(mfrow = c(1, 2))
> res1 <- model1$residuals
> qqnorm(res1);qqline(res1)
> plot(model1$fitted.values, res1)
> abline(h = 0, col = "red")
```





Analysis and Interpretation

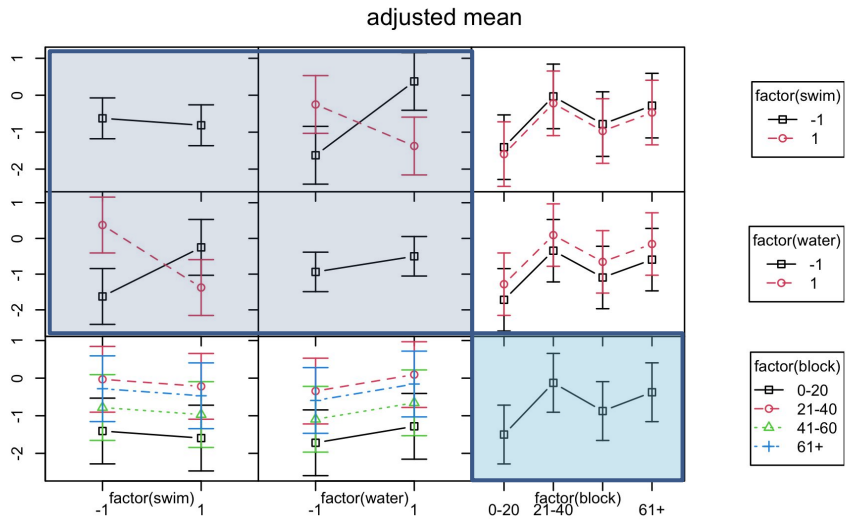
Normal QQ Plot
Points mostly follow a 45 degree diagonal line, with some tail behavior. Overall, the residuals are normally distributed.

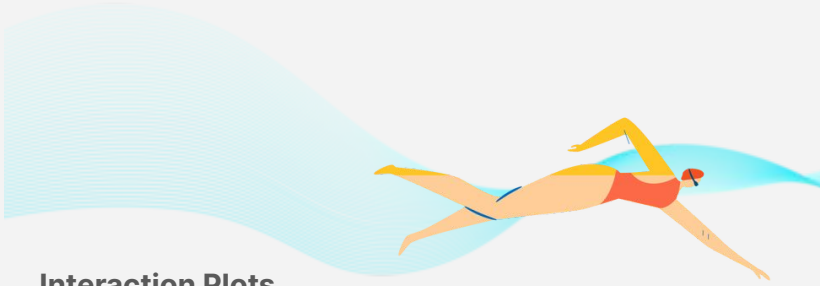
Residuals vs. Fitted Values Plot
The residuals appear to be randomly scattered without any clear pattern, suggesting that the variance of the residuals is constant.

Data Analysis

Reading in Data

```
> library(phia)
> plot(interactionMeans(model1))
```





Interaction Plots

Main effects:

- Longer swimming distance → more decrease in blood glucose levels
- More water consumed → less decrease in blood glucose levels

Interaction effects:

- The interaction between swimming distance and amount of water consumed is visually evident
- Aligns with the marginal significance found in the ANOVA summary

Blocks:

- The value of the response variable across different age groups is visibly different
- Generally, older age groups have smaller decreases in blood glucose level.

Conclusion

Our main takeaways

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- Swimming distance and water consumption do **not** have significant main effects on blood glucose level changes at the 0.05 significance level.
- Blocking showed smaller decrease in blood glucose levels for higher age groups.
- Marginally significant interaction between swimming distance and water consumption with a p-value of 0.0567.

  → The effect of one factor is not consistent across the levels of the other factor, so both factors should be **considered together** when examining their effects on blood glucose levels.

Limitations

1 Sample Size and Power

The small sample size of 32 participants limits the statistical power of the study.

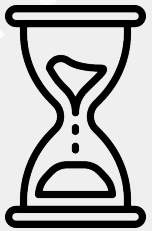
It is challenging to detect meaningful effects or draw reliable conclusions.

2 Uncontrolled factors

Factors such as diet, health status, and lifestyle, which are not controlled for in the study, can introduce confounding variables that may affect the outcomes.

3 Short-Term Focus

Short-term studies may not capture the long-term impacts of the treatments, limiting the understanding of these factors' sustained effects.



Thank you

Stay healthy and hydrated!