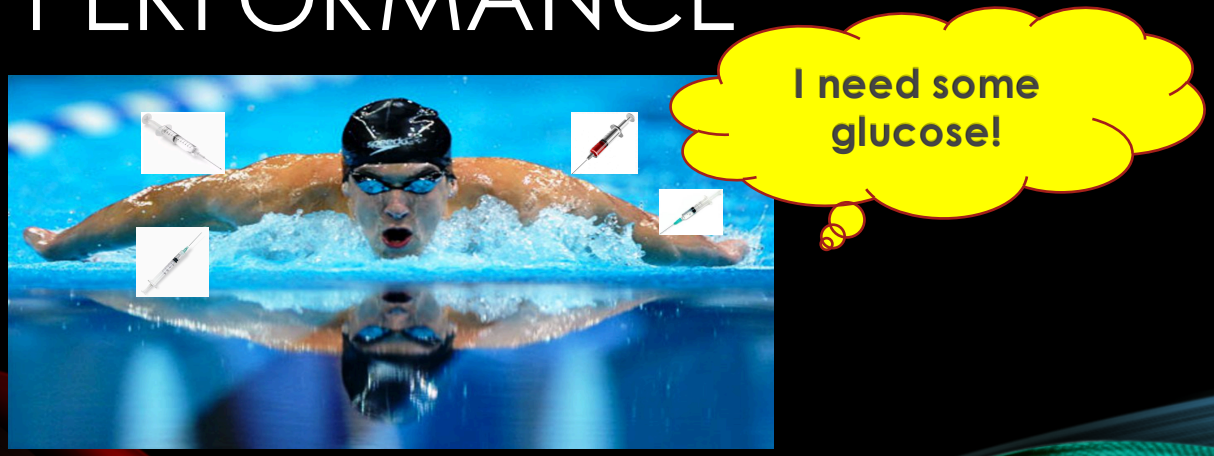
EFFECTS OF GLUCOSE CONCENTRATION ON SWIMMING PERFORMANCE



H&K

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TOPIC

When people have a severe cold, we often get injection of glucose, in Asia and then the cold is disappeared, which implies that glucose might help people to get energy.

So, we have thought that glucose will affect and improve the human's ability for exercising. To be specific, we wanted to check if how much the glucose will affect the mean time of swimming freestyle 50m, depending on the amount of glucose 5% and 10%.

DESIGN TACTICS

- We used completely randomized factorial design with blocking to reduce the variation in error, which will increase precision of estimates and the power of hypothesis tests.

- Blocking (Age) : We used age as a block because we intuitively know age is a nuisance factor which can influence our response variable because a person's athletic capability deteriorates with age

- We cut the age by 10. According to the USA swimming rules, USA Swimming has established unisex age-groups based in chronological age. It starts from 10 years & under. So, it derived to our swimming age's range.

- To achieve more precise conclusion, we will first execute completely randomized factorial design with one replication and then execute it with two replications and compare each other to make sure those two results are met.

HYPOTHESIS

- Ho:There is no significant difference of swimming time at 50m regardless of glucose level.
- H1:At least one of glucose levels will yield the significantly different mean time of swimming 50m.

- Ho:There is no significant difference of swimming time at 50m between age groups.
- H1:There is significant difference of swimming time at 50m between age groups.

DATA COLLECTION

- All cities in the Island are numbered in order and only one city named Vardo is selected by the sampling function in R studio randomly.
- To achieve perfectly randomized data, we investigated for each 10 people whose ages are from 10 to 19 in the city by assigning numbers in each house which have at least one teenager.
- The houses are excluded, which have the out of range of ages that we are looking for.
- After then, we collected all houses and did the random sample by using R-built in sample() function among those houses.
- We applied this method to 20's, 30's 40's generation.
- We searched for 40 people whose ages are from 10 to 49 in the city.
- The ages are divided into 4 groups, which are 10's, 20's, 30's and 40's.
- Each group have 10 people.
- After we collected the data, we made each person swim freestyle 50m without glucose and with glucose 5% and 10% step by step.

DATA

10's

3	name	sex	age	address	dosage 0	dosage5	dosage10
4	Elias Eklund	M	12	vardo4	58	50.6	51.7
5	Nils Sorensen	M	11	vardo14	57.7	56.5	57
6	Sanna Jensen	F	19	vardo 21	65.8	62.7	63.6
7	Daiki Connolly	F	18	vardo 21	65.3	62.9	63.1
8	Justin Connolly	M	17	vardo 21	57.1	54.9	55.9
9	Mia Eklund	F	16	vardo 21	63.8	60.9	61.1
10	Laura Eklund	F	11	vardo 21	68.7	65.3	66.2
11	Emma Solberg	F	18	vardo92	67.2	65.4	66.1
12	Magdalena Sorensen	F	10	vardo 108	66.4	64.2	63.1
13	Nicole Edwards	F	19	vardo 178	65.7	62.1	62.8
14	total				635.7	605.5	610.6
15	ave				63.57	60.37777778	61.06

20's

44	name	sex	age	address	dosage 0	dosage 5	dosage 10
45	Lucia Blomgren	F	32	vardo69	50.2	47.8	46.2
46	Sanna Eklund	F	31	vardo 4	48.3	45.3	45.3
47	Tyler jones	M	30	vardo6	48	45.1	44.9
48	Philipp Larsen	M	34	vardo 327	74.8	70.2	71.1
49	Theresa Sorensen	F	33	vardo 327	43.5	40.9	41.8
50	Ryan Connolly	M	31	vardo 14	50.3	47.6	48.3
51	Adam Connolly	M	37	vardo21	49.8	48.5	47.5
52	Ingrid Eklund	F	36	vardo 21	60.4	58.2	59.5
53	Daichi Jackson	M	31	vardo 69	47.3	48.5	48.8
54	Lucia Sorensen	F	31	vardo 108	61.2	58.9	59.2
55	total				533.8	511	512.6
56	ave				53.38	51.1	51.26

30's

22	name	sex	age	address	dosage 0	dosage 5	dosage 10
23	Reina Connolly	M	21	vardo 833	53.9	58.9	55.8
24	Jeneve carlsen	F	24	vardo1	57	52.3	52.9
25	Marcel Eklund	F	21	vardo 833	52.8	53.7	50.5
26	Lea Thorn	F	23	vardo366	51.7	53	51
27	Molly Collins	F	26	vardo 587	54	52.1	53.7
28	Lukas Solberg	m	26	vardo 587	56	47.3	54.8
29	Sarah Page	F	20	vardo 17	53.2	47.3	52.4
30	Erik Eklund	M	20	vardo 17	48.5	50.3	47.5
31	Andrew McCathy	M	21	vardo20	48.9	51.9	48
32	Jeneve Thorn	F	20	vardo 20	50.5	50.8	50.3
33	total				526.5	517.6	516.9
34	ave				52.65	51.76	51.69

40's

69	name	sex	age	address	dosage 0	dosage 5	dosage 10
70	Kaeda Colins	F	40	vardo221	52.7	48.9	48
71	Evan Regan	M	40	vardo 221	65.9	59.5	62.1
72	Kin Jackson	M	48	vardo 66	66.5	63.5	64.2
73	Erla Thorn	F	46	vardo 66	67.8	64.5	64.2
74	Sophia Sorensen	F	45	vardo 90	60.5	58.6	58.9
75	Brenda Solberg	F	47	vardo 92	61.5	59.2	58.8
76	Kin Murphy	M	47	vardo 92	59.2	57.3	56.9
77	Paul Eklund	M	48	vardo 233	58.5	55.2	56.1
78	Emma Kimura	F	48	vardo 233	60.4	57.3	56.2
79	Charlotte Simon	F	47	vardo 253	61.2	58.2	57.4
80	total				614.2	582.2	582.8
81	ave				61.42	58.22	58.28

DATA FRAME: MEAN TIME SWIMMING BY EACH GROUP(ONE REPLICATION)

```
##    glucose  data ages_blocking
## 1       0% 63.57          10's
## 2       5% 51.76          20's
## 3      10% 51.26          30,s
## 4       0% 61.42          40's
## 5       5% 60.37          10's
## 6      10% 51.69          20's
## 7       0% 53.38          30,s
## 8       5% 58.22          40's
## 9      10% 61.06          10's
## 10      0% 52.65          20's
## 11      5% 51.10          30,s
## 12     10% 58.28          40's
```

The numbers in data column represent the average swimming time at 50m performed by 10 people.

We used one replication in here.

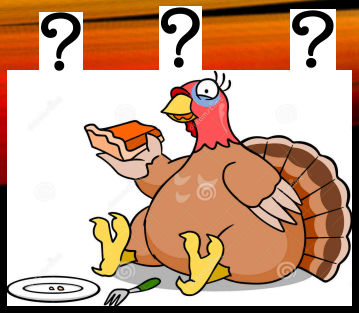
ANALYSIS

```
##              Df Sum Sq Mean Sq F value   Pr(>F)
## ages_blocking  3 225.81   75.27  210.69 1.81e-06 ***
## glucose        2  14.04    7.02   19.65  0.00232 **
## Residuals      6   2.14    0.36
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
par(mfrow=c(2,2))
plot(aov(data~ages_blocking+glucose, data=df))
```

- We drew a ANOVA table based on our data.
- Since both glucose and blocking factors P-value are less than 0.05, we decide to reject both of our null hypothesis and conclude that at least one of glucose levels will yield the significantly different mean time of swimming 50m.

And blocking factor has a large effect and that the noise reduction obtained by the blocking was probably Helpful in improving the precision of the comparison of treatment means.



MULTIPLE COMPARISONS (WITH ONE REPLICATION)

- Since we reject the null hypothesis and conclude that there is at least one of glucose levels will yield the significantly different mean time of swimming 50m, we have investigate which glucose level is different from Which -> Tukey Method.

```
> t12=(55.36-57.75)/(sqrt( 0.36)*sqrt(0.5))
> abs(t12)
[1] 5.633284
> t13=(55.57-57.75)/(sqrt( 0.36)*sqrt(1/2))
> abs(t13)
[1] 5.138309
> t23=(55.57-55.36)/(sqrt( 0.36)*sqrt(1/2))
> abs(t23)
[1] 0.4949747
> (1/sqrt(2))*qtukey(1-0.05,3,6)
[1] 3.068274
```

Followed by the formula of Tukey method, we get the results that pair 1,2 and pair 1,3 are different at 5% level.

TUKEY CONCLUSION..

T(1 vs 2) : mean time swimming without glucose vs 5% level. <- significant
T(1 vs 3) : mean time swimming without glucose vs 10% level. <- significant
T(2 vs 3) : mean time swimming with 5% glucose vs 10% glucose level. <- not significant

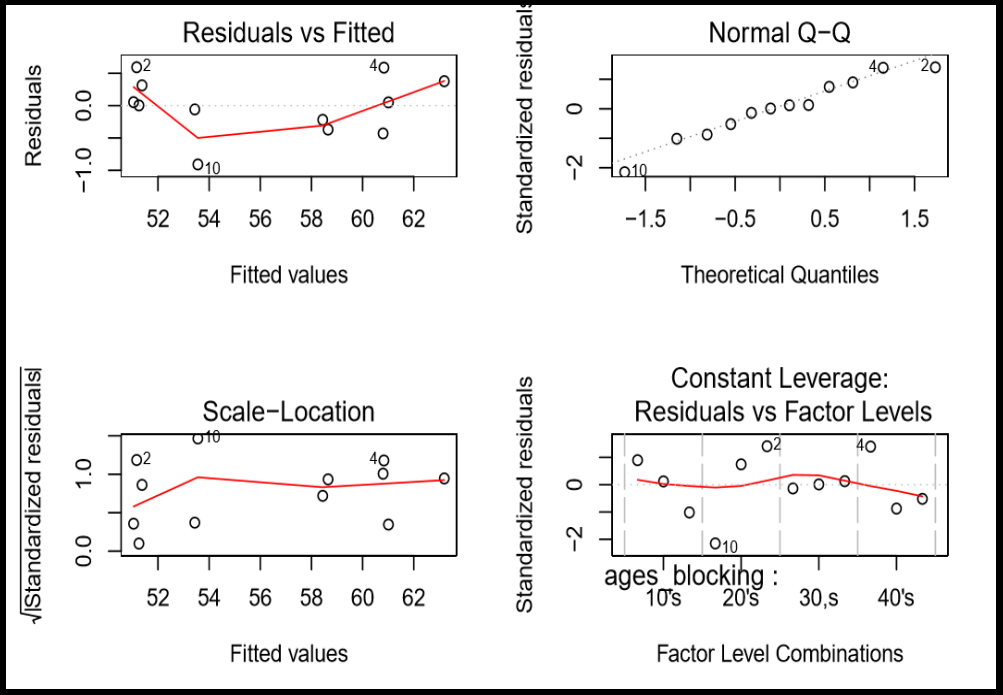
The result implies that dosage of glucose reduces the mean time of swimming 50 meters

but the level of dosage between 5% and 10% does not have a significant impact.

In other words, glucose injection will improve physical performance but more and more

glucose injection will not guarantee to get shorten the mean time of swimming 50 meters.

DIAGNOSTIC: NORMALITY CONDITION



1. Residual vs fitted plots is mostly scattered and there is no pattern.

2. The points are on the straight diagonal line from the normal QQ plot.

3. The residuals follow the constant variance

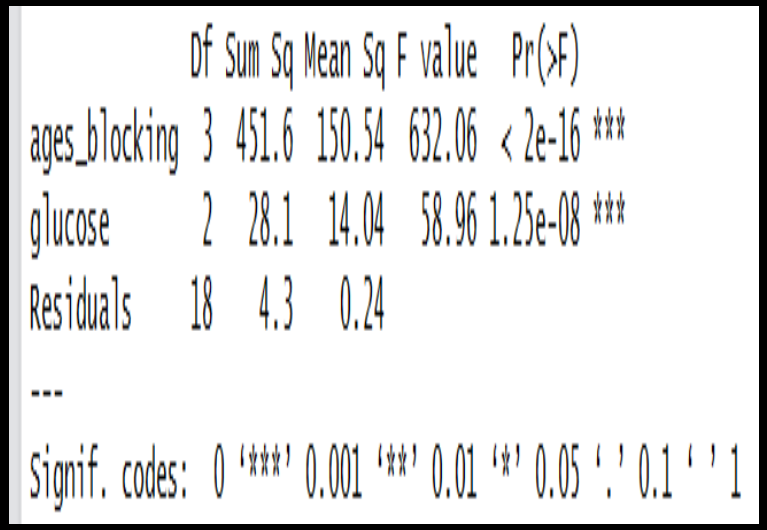
Normality conditions are satisfied.

DATA FRAME: MEAN TIME SWIMMING BY EACH GROUP(TWO REPLICATIONS)

	glucose	data	ages_blocking
1	0%	63.57	10's
2	5%	51.76	20's
3	10%	51.26	30,s
4	0%	61.42	40's
5	5%	60.37	10's
6	10%	51.69	20's
7	0%	53.38	30,s
8	5%	58.22	40's
9	10%	61.06	10's
10	0%	52.65	20's
11	5%	51.10	30,s
12	10%	58.28	40's
13	0%	63.57	10's
14	5%	51.76	20's
15	10%	51.26	30,s
16	0%	61.42	40's
17	5%	60.37	10's
18	10%	51.69	20's
19	0%	53.38	30,s
20	5%	58.22	40's
21	10%	61.06	10's
22	0%	52.65	20's
23	5%	51.10	30,s
24	10%	58.28	40's

Data Frame achieved by two replications.

ANALYSIS (TWO REPLICATION)



	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
ages_blocking	3	451.6	150.54	632.06	< 2e-16	***
glucose	2	28.1	14.04	58.96	1.25e-08	***
Residuals	18	4.3	0.24			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- This ANOVA table shows that the p-values of factor and block become more smaller than the p-values originated from one replication. It implies that we get more precise results using two replications.
- Since our p-value for glucose level is smaller than 0.05, further investigation is required to see which level is significantly make different mean time swimming.

MULTIPLE COMPARISONS (WITH TWO REPLICATIONS)

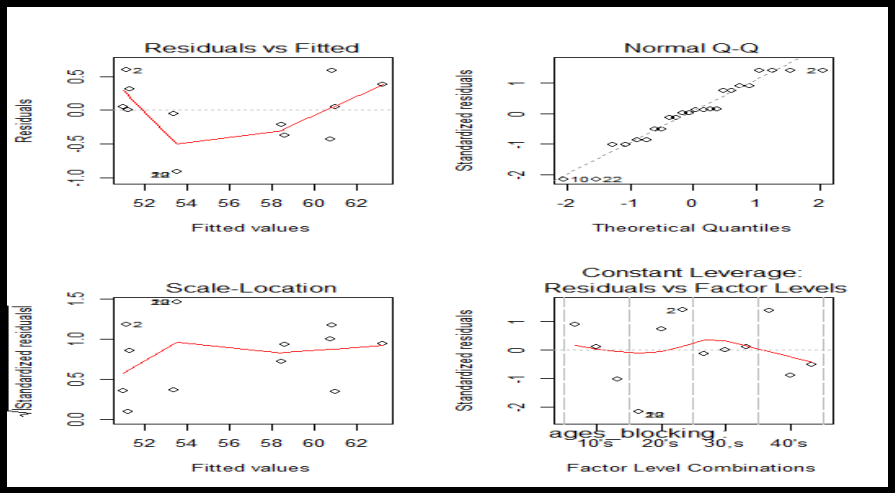
```
> t12=(55.36-57.75)/(sqrt( 0.24)*sqrt(0.5))
> abs(t12)
[1] 6.899336
> t13=(55.57-57.75)/(sqrt( 0.24)*sqrt(1/2))
> abs(t13)
[1] 6.293118
> t23=(55.57-55.36)/(sqrt( 0.24)*sqrt(1/2))
> abs(t23)
[1] 0.6062178
> (1/sqrt(2))*qtukey(1-0.05,3,6)
[1] 3.068274
```

- Ever since SSE value achieved by two replication is much smaller than SSE from one replication, our MSE value became smaller than before.

- Followed by the formula of Tukey method, we get the results that pair 1,2 and pair 1,3 are different at 5% level.

The result derived by one replication met with result derived by two replications.

DIAGNOSTIC NORMALITY CONDITION (WITH TWO REPLICATIONS)



- The residuals follow the constant variance
- The points are on the straight diagonal line from the normal QQ plot.
- All points are scattered and no pattern from the Residual vs fitted plot.

Normality conditions are satisfied.

CONCLUSION

- Does glucose has an effect on the performance of swimming 50 meters with freestyle ??
- RANDOMIZATION (Random sampling) .
- REPLICATION (1 Replication vs 2 Replications).
- Blocking (Age).
- Confidence level : 95 %.
- Tukey Method (T12,T13 significantly different but T23 is not significant).