

Biostatistics 140.655, 2017-8 **QUIZ 1 SOLUTION**

Scientific Background:

Assume you are a researcher interested in mental health symptoms among critically ill ICU survivors. You administered the Short Form (36) Health Survey (SF-36) to 100 patients that consented to participate in your study. The SF-36 will be administered at hospital discharge (time 0) and then monthly for 4 months. You are specifically interested in the mental health score of the SF-36.

A priori you believe that the mental health symptoms of the ICU survivors will improve over the course of the follow-up and you state that you will estimate the improvement in mental health symptoms comparing 1 to 4 months post hospital discharge to hospital discharge (time 0 or baseline).

Population parameters:

Assume that for our population of critically ill ICU survivors, the SF-36 mental health scores follow a multivariate normal distribution as follows:

$$\begin{pmatrix} Y_{i0} \\ Y_{i1} \\ Y_{i2} \\ Y_{i3} \\ Y_{i4} \end{pmatrix} \sim MVN \left(\begin{pmatrix} 35 \\ 38 \\ 41 \\ 44 \\ 47 \end{pmatrix}, \begin{pmatrix} 100 & 85 & 72 & 61 & 52 \\ 85 & 100 & 85 & 72 & 61 \\ 72 & 85 & 100 & 85 & 72 \\ 61 & 72 & 85 & 100 & 85 \\ 52 & 61 & 72 & 85 & 100 \end{pmatrix} \right)$$

For your sample of 100 patients, you obtained the following summary statistics.

```
. summ y0 - y4
```

Variable	Obs	Mean	Std. Dev.	Min	Max
y0	100	36.42319	10.22092	3.664389	68.4766
y1	100	39.23928	9.116138	17.71607	57.18258
y2	100	42.92986	10.29955	20.1512	69.40082
y3	100	45.52053	9.645908	21.85929	67.51713
y4	100	49.0611	9.705016	29.17642	74.25333

```
. pwcorr y0 - y4
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	y0	y1	y2	y3	y4
y0	1.0000				
y1	0.8292	1.0000			
y2	0.7015	0.8522	1.0000		
y3	0.6397	0.7435	0.8815	1.0000	
y4	0.5311	0.5787	0.6941	0.6512	1.0000

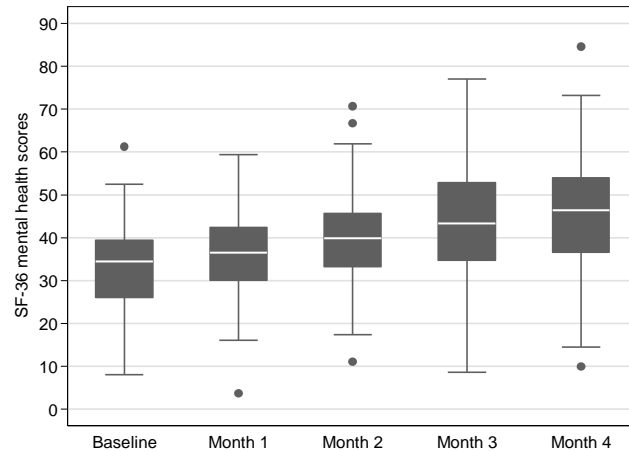
1. The population mean SF-36 mental health score measured 2 months after hospital discharge is
 - a. 38
 - b. 39.24
 - c. 41
 - d. 42.93
2. The sample covariance for SF-36 mental health scores measured at hospital discharge and 1 month after hospital discharge is
 - a. 100
 - b. 85
 - c. $10 \times 10 \times 0.83$
 - d. $10.22 \times 9.12 \times 0.83$
3. The sample mean improvement in SF-36 mental health scores comparing 4 months post hospital discharge to hospital discharge is
 - a. $49.06 - 45.52$
 - b. $49.06 - 36.42$
 - c. $47 - 44$
 - d. $47 - 35$

The sample mean improvement in SF-36 mental health scores comparing 1 month post hospital discharge to hospital discharge is 2.82. The corresponding 95% confidence interval for the population mean improvement is 1.68 to 3.96 based on the paired t-test procedure.

4. The “95%” from a 95% confidence interval means:
 - a. The probability that the true mean improvement is in the interval 1.68 to 3.96 is 0.95
 - b. We are 95% confident that the true mean improvement is in the interval 1.68 to 3.96.
 - c. 95% of the possible confidence intervals constructed using the paired t-test procedure on samples of size 100 from our population will contain the true mean improvement.
 - d. The interval 1.68 to 3.96 contains the sample mean improvement for 95% of possible samples drawn from the population.
5. Which of the following confidence intervals could have been generated by applying the two-sample t-test procedure to your data?
 - a. 1.40 to 3.68
 - b. 0.25 to 5.39
 - c. 1.00 to 6.14
 - d. 1.68 to 4.51

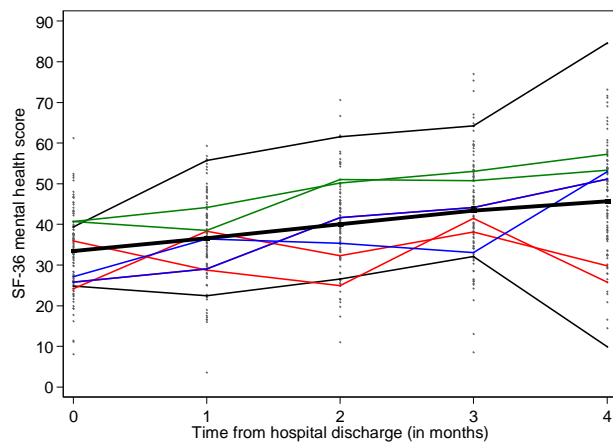
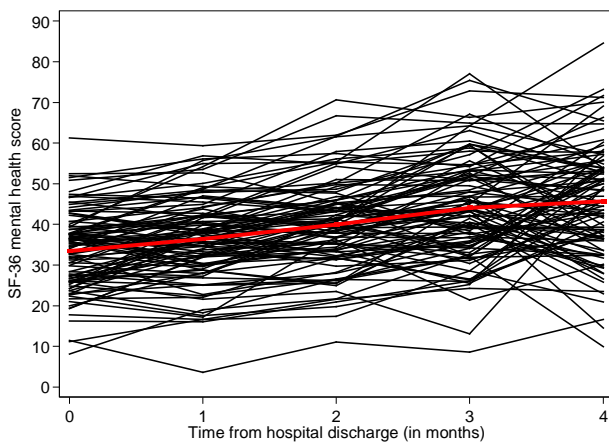
NOTE: The confidence interval based on the two-sample t-test procedure has to be wider than the paired t-test confidence interval AND centered around the sample mean improvement comparing 1-month post discharge to hospital discharge (2.82).

Imagine now that you are interested in a different population; specifically, ICU survivors who were treated for acute respiratory distress syndrome (ARDS) while in the ICU. ARDS requires that patients are mechanically ventilated; often these patients are heavily sedated while in the ICU and can exhibit worse mental health symptoms than non-ARDS ICU survivors. Your study design is the same; i.e. you recruited 100 surviving ARDS patients and will assess their mental health symptoms at hospital discharge and monthly thereafter for 4 months. The figures below displays the distribution of SF-36 mental health symptoms measured at each time.



6. The figure above containing the boxplots of SF-36 mental health scores at each time demonstrates that there is large variation in the scores at each time point and that the variation in the scores is increasing over time. In terms of understanding potential sources of variation,
- This figure is limiting in that it does not display the mean SF-36 mental health score at each time.
 - This figure is limiting since there is no way to visualize if the variation is due to differences between patients or variation within a patient over time.
 - This figure clearly demonstrates that the majority of the variation is due to differences between patients
 - This figure clearly demonstrates that the majority of the variation is due to differences within a patient over time.

You also created two spaghetti plots; one displaying each individual patient's data connected over time and one where you highlighted patients based on the size of the residuals after estimating the mean at each time point. Specifically, you highlighted the patients with the largest and smallest residual SF-36 mental health scores (black lines), patients with residuals in the 75th percentile of residuals (green lines), patients with median residuals (blue lines), and patients with residuals in the 25th percentile of residuals (red lines).



7. Using the two spaghetti plots, you would conclude the following:
- a. The variation in SF-36 mental health scores is attributable only to differences in the patients at hospital discharge
 - b. The variation in SF-36 mental health scores is attributed only to differences in how the patients scores change over time (i.e. different slopes)
 - c. The variation in SF-36 mental health scores is attributed only to natural fluctuations of the scores within a person over time
 - d. The variation in SF-36 mental health scores is largely attributable to both differences in the patients at hospital discharge and differences in how the patients scores change over time (i.e. different slopes)