140.656 Quiz 4

Instructions: This quiz is an open note (lecture and lab materials) and open book quiz. You MUST WORK ALONE to complete the quiz. You should submit your solution via Courseplus (Go to Class Materials and Resources tab and then Quizzes tab) and anytime between 1pm on Wed ~~5/1~~ and 5pm Friday ~~5/3~~. When you submit your responses to Courseplus you are pledging that you worked alone on the quiz and that you will NOT discuss the quiz with any student in the course until after 5pm on Friday ~~5/3~~.

Please check course plus for due dates.

Data: Acute respiratory tract infection (ARI) is a common disease among children; pneumonia being a leading cause of death in young children in developing countries. In China, the standard medication for ARI is antibiotics, which has led to concerns about antibiotics misuse and resultant drug resistance. As a response, the World Health Organization (WHO) introduced a program of case management for ARI in children under 5-years old in China in the 1990s. Here we consider data on physicians' prescribing behavior of antibiotics in two Chinese counties, only one of which was in the WHO program.

These data have previously been analyzed by Yang (2001); see also Skrondal and Rabe-Hesketh (2003).

Medical records were examined for medicine prescribed and a correct diagnosis determined from symptoms and clinical signs. The antibiotic prescription was defined as abuse if there were no clinical indications.

Variables: The dataset antibiotics.dta (available on the course website) has the following variables.

Level 1 (child):

- **abuse**: classification of prescription (1: correct use; 2: abuse of one; 3: abuse of several)
- **abuse_recoded:** Binary indicator for antibiotic abuse (1: abuse of one or several, 0: correct use).
- **age**: age in years (0-4)
- **temp**: body temperature, centered at 36 degrees Centigrade
- **Paymed**: dummy variable for patient's family paying for his or her own medication
- **Selfmed**: dummy variable for self-medication before seeing doctor
- **Wrdiag**: dummy variable for diagnosis classified as wrong

Level 2 (doctor):

- **doc**: doctor identifier
- **DRed**: doctor's education (ordinal with six categories from self-taught to medical school)

Level 3 (hospital):

- **hosp**: hospital identifier
- **WHO**: dummy variable for hospital's being in the WHO program

Goal: Determine effectiveness of the WHO program on antibiotic abuse.

The data from the study represent three level hierarchical data where patients are nested within physicians (doctors) who are nested within hospital. Consider the following **basic** model:

$$Logit\left[\Pr\left(Y_{ijk}=1\right)\right]=\beta_0+U_i+U_j+\beta_1 WHO_i$$
$$U_i\sim N(0,\sigma^2), U_j\sim N(0,\tau^2)$$

$where\ i\ denotes\ the\ hospital, j\ denotes\ the\ doctor, and\ k\ denotes\ the\ patient\ and$
$WHO_i\ is\ the\ indicator\ that\ hospital\ i\ was\ participating\ in\ the\ WHO\ program\ or\ not.$

Question 1: The value $\exp(\beta_0)\big/(1+\exp(\beta_0))$ can be interpreted as:

a) The log odds of antibiotic abuse among patients within the study whom were not exposed to the WHO program
b) The probability of antibiotic abuse among patients within the study whom were not exposed to the WHO program
c) The log odds of antibiotic abuse among patients who were not exposed to the WHO program and who were treated at the average hospital by the average doctor
d) The probability of antibiotic abuse among patients who were not exposed to the WHO program and who were treated at the average hospital by the average doctor

Question 2: The main effect of the WHO program was estimated to be $\exp(\beta_1)=0.36$ (SE 0.10). The interpretation of this main effect is

a) The odds of antibiotic abuse are 36 percent smaller among patients treated at hospitals that participated in the WHO program vs. those whom were not.
b) The odds of antibiotic abuse are 64 percent smaller among patients treated at hospitals that participated in the WHO program vs. those whom were not.
c) Among patients seen by doctors and at hospitals with the same propensity to abuse antibiotics, the odds of antibiotic abuse are 36 percent smaller among the patients treated at hospitals that participated in the WHO program vs. those whom were not.
d) Among patients seen by doctors and at hospitals with the same propensity to abuse antibiotics, the odds of antibiotic abuse are 64 percent smaller among the patients treated at hospitals that **did** participate in the WHO program vs. those whom were treated at hospitals **that did not participate** in the WHO program.

Question 3: In a random intercept logistic model, the interpretation of the main effect for level-2 (or higher) variables requires that we fix or hold constant the random intercept(s). For example, to interpret the WHO program effect (a level 3 fixed effect), you must hold constant the hospital random effect (U_i) and the doctor random effect (U_j). For many people this interpretation

a) Represents an extrapolation. That is, we don't observe patients seen at hospitals and by doctors who have the same random effects but where the hospitals represent both the presence and absence of the WHO program.
b) Is reasonable regardless of the presence of a level-3 random intercept since to estimate this effect, we would pool information from hospitals and doctors with similar random intercepts some of which would and would not be participating in the WHO program.

Question 4: The estimate of τ^2 (the random intercept for doctors) was 0.23. The **base** model was extended to include the doctor's education level (an ordinal variable with six categories from self-taught to medical school) and several other variables that described the composition of patients including age, body temperature, type of payment for medication, whether or not the patient had self-medicated before seeing the doctor and whether or not the patient's condition was correctly classified. In this extended model, the estimate of τ^2 was 0.08. This indicates

a) That doctor's education level did not explain any variation in the log odds of antibiotic abuse across doctors.
b) That only the doctor's education level explained a significant (roughly two thirds) of the variation in the log odds of antibiotic abuse across doctors.
c) A significant fraction of the variation in the log odds of antibiotic abuse across doctors was explained by the doctor's education level or by the composition (i.e. characteristics) of the patients seen by the doctors.
d) A significant fraction of the variation in the log odds of antibiotic abuse across doctors was explained by the composition of the patients seen by the doctors.

Question 5: A reasonable approach to understand if the reduction in τ^2 described in Question 4 is attributable to the doctor's education level after accounting for the patient composition would be to:

a) Add the doctor's education level to the **base** model, record the value of τ^2. Then start with the **base** model and add the patient characteristics, record the value of τ^2. Compare the two values of τ^2.
b) Add the patient characteristics to the **base** model, record the value of τ^2. Add the doctor's education level to the **base** model with patient characteristics already added, record the value of τ^2. Compare the two values of τ^2.
c) Add the doctor's education level to the **base** model, record the value of τ^2. Add the patient characteristics to the **base** model with doctor's education level already added, record the value of τ^2. Compare the two values of τ^2.