More Complicated Modeling Exercise
Yet another example using NMES
Solution

The easiest way to address the questions is to build a regression model which allows for a separate log(positive expenditures) vs. age relationship for each combination of gender and mscd.

Model:

$$E(\log \$) = \beta_0 + \beta_1 age + \beta_2 gender + \beta_3 mscd + \beta_4 age \times gender + \beta_5 age \times mscd + \beta_6 gender \times mscd + \beta_7 age \times gender \times mscd + \varepsilon$$

where age = 40 to 94, gender = 1 if male, 0 if female, mscd = 1 if yes, 0 if no disease.

Model for females with no disease

$$E(\log \$) = \beta_0 + \beta_1 age + \varepsilon$$

β_1 is the expected rate of change in log$ per year increase in age for females with no disease.

Model for males with no disease:

$$E(\log \$) = \beta_0 + \beta_1 age + \beta_2 + \beta_4 age + \varepsilon$$
$$E(\log \$) = \beta_0 + \beta_2 + (\beta_1 + \beta_4) age + \varepsilon$$

$\beta_1+\beta_4$ is the expected rate of change in log$ per year for males with no disease
β_4 is difference in the rate of change in log$ comparing males and females with no disease

Model for females with a mscd:

$$E(\log \$) = \beta_0 + \beta_1 age + \beta_3 + \beta_5 age + \varepsilon$$
$$E(\log \$) = \beta_0 + \beta_3 + (\beta_1 + \beta_5) age + \varepsilon$$

$\beta_1+\beta_5$ is the expected rate of change in log$ per year for males with no disease
β_5 is difference in the rate of change in log$ comparing females with a mscd to females without a mscd

Model for males with a mscd:

$$E(\log \$) = \beta_0 + \beta_1 age + \beta_2 + \beta_3 + \beta_4 age + \beta_5 age + \beta_6 + \beta_7 age + \varepsilon$$
$$E(\log \$) = \beta_0 + \beta_2 + \beta_3 + \beta_6 + (\beta_1 + \beta_4 + \beta_5 + \beta_7) age + \varepsilon$$

$\beta_1+\beta_4+\beta_5+\beta_7$ is the expected rate of change in log$ per year for males with disease

$\beta_4+\beta_7$ is difference in the rate of change in log$ comparing males to females who have a mscd
$\beta_5+\beta_7$ is difference in the rate of change in log$ comparing males with a mscd to males without a mscd

Using the model that you specified above, describe the statistical tests that you would perform to answer the following questions:

a) Is there evidence in the data to suggest that persons with a mscd have higher log(positive expenditures) compared to those without a mscd?

Test everything with mscd included H_0: $\beta_3 = 0$, $\beta_5 = 0$, $\beta_6 = 0$, $\beta_7 = 0$

b) Is the rate at which log(positive expenditures) change with age different comparing persons with and without a mscd?

Test all interactions with mscd and age H_0: $\beta_5 = 0$, $\beta_7 = 0$

c) Is there evidence in the data to suggest that gender is associated with log(positive expenditures)?

Test everything with gender included H_0: $\beta_2 = 0$, $\beta_4 = 0$, $\beta_6 = 0$, $\beta_7 = 0$

d) Is the log(positive expenditures) vs. age relationship different comparing males and females?

Test all interactions with gender and age H_0: $\beta_4 = 0$, $\beta_7 = 0$

e) Is the log(positive expenditures) vs. age relationship different comparing males and females with a mscd?

Test H_0: $\beta_7 = 0$

f) Is the log(positive expenditures) vs. age relationship different comparing males and females without a mscd?

Test H_0: $\beta_4 = 0$