

8.21. In a regression analysis of on-the-job head injuries of warehouse laborers caused by falling objects,

- Y is a measure of severity of the injury,
- X1 is an index reflecting both the weight of the object and the distance it fell, and
- X2 and X3 are indicator variables for nature of head protection worn at the time of the accident, coded as follows:

Type of Protection	X ₂	X ₃
Hard hat	1	0
Bump cap	0	1
None	0	0

The response function to be used in the study is $E\{Y\} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$.

a. Develop the response function for each type of protection category.

Type of Protection	X ₂	X ₃	Expected performance $E\{Y\}$
Hard hat	1	0	$E\{Y\}_{\text{hard hat}} = \beta_0 + \beta_1 X_1 + \beta_2(1) + \beta_3(0) = \beta_0 + \beta_1 X_1 + \beta_2$
Bump cap	0	1	$E\{Y\}_{\text{bump cap}} = \beta_0 + \beta_1 X_1 + \beta_2(0) + \beta_3(1) = \beta_0 + \beta_1 X_1 + \beta_3$
None	0	0	$E\{Y\}_{\text{none}} = \beta_0 + \beta_1 X_1 + \beta_2(0) + \beta_3(0) = \beta_0 + \beta_1 X_1$

b. For each of the following questions, specify the alternatives H₀ and H_a for the appropriate test:

(1) With X₁ fixed, does wearing a bump cap reduce the expected severity of injury as compared with wearing no protection?

$H_0: \beta_3 = 0$
 $H_a: \beta_3 < 0$
 H₀ true: Holding X₁ (weight & distance) constant, the expected Y (injury severity) is not significantly reduced by wearing bump cap as compared to wearing no protection.
 H_a true: Holding X₁ (weight & distance) constant, the expected Y (injury severity) is significantly reduced by wearing bump cap as compared to wearing no protection.

(2) With X₁ fixed, is the expected severity of injury the same when wearing a hard hat as when wearing a bump cap?

$H_0: \beta_2 = \beta_3$
 $H_a: \beta_2 \neq \beta_3$
 Holding X₁ constant, expected Y (injury severity) is the same between when wearing a hard hat and wearing a bump cap.
 Holding X₁ constant, expected Y (injury severity) is not same when wearing a hard hat as when wearing a bump cap.