Logistic regression analysis goals and approaches

HL Chapter 4 – part 3

Determine the goal of the analysis

- Are all risk factors of equal interest?

- Is there a risk factor of primary interest?

- Is the model explanatory or predictive?

Potential goals

For all analyses…

Get to know the study variables

- Cross-tabulate categorical variables
- Calculate descriptive statistics for continuous variables (separately for each outcome level)
- Locate unusual or incorrect values

Clean the data

- Delete or correct unusual or incorrect values
- For categorical variables with sparse cells,
  - Collapse categories if possible and meaningful
  - Remove categories otherwise
- As a last resort, remove variables

Select the model covariates

- Model selection is an art as much as it is a science
- Different models may highlight different aspects of the data set






Options

- Purposeful selection
- Automated selection

Important question

- How many variables can be included in a logistic regression model?
- Rough guide:
  No more variables than the "least frequent outcome" divided by 10
- Example:
  n=200, 50 died and 150 lived
  ➔ number of model covariates ≤ 50/10=5 (roughly)

Purposeful model selection…

Potential goal 1: To get the most complete "picture" of the risk factors for the outcome

- Statistically significant variables, confounders and effect modifiers should be included in the model

Univariate analysis

- Check scale of continuous variables
- Determine univariate significance ($p<0.25$) of each study variable

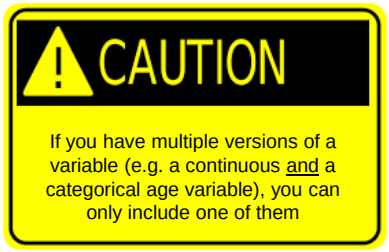
Multivariate analysis

Step 1: Initial main effects model

Include in the model

- Variables that were univariately significant at the 0.25 level
- Biologically important variables
- Known or suspected confounders
- Known or suspected effect modifiers

Multivariate analysis

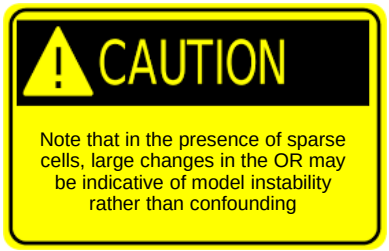


Multivariate analysis

Step 2: Statistical significance and confounding

- Remove the least significant variable and check for confounding
- Return the variable to the model if it appears to be a confounder based on the 10%-change-in-OR rule
- Continue until all model covariates are biologically important, statistically significant ($p<0.05$) or confounders
- You have created your provisional main effects model

Multivariate analysis



Multivariate analysis

Step 3: Additional variables

- Consider variables that have not yet been tested multivariately
- Add these variables to the provisional main effects model
- Determine whether these variables act as confounders or are statistically significant in the multivariate model ($p<0.05$)

Multivariate analysis

Step 4: Scale

- Recheck the scale of all continuous model covariates
- Include correctly scaled variables in the model
- You have created the final main effects model

Multivariate analysis

Step 5: Interactions

- Test significance of interactions between model covariates (p<0.1)
- Test significance of interactions between model covariates and "left out" variables (p<0.1)

CAUTION

Variables included in an interaction must also be included as main effects

Multivariate analysis

Step 6: Model stability

- Look for unreasonably large ORs or standard errors
- If everything looks OK, you have created your final model

Potential goal 2: To get the most complete "picture" about one specific risk factor

- The risk factor and confounders and effect modifiers of the risk factor should be included in the model

Bi-/tri-variate analysis

- Include the risk factor (RF) in the model
- Check scale of continuous variables
- Determine which variables are confounders or effect modifiers of RF

Multivariate analysis

Step 1: Initial model

Include in the model

- RF
- Confounders of RF detected in the bivariate analyses
- Effect modifiers of RF detected in the trivariate analyses (include each effect modifier as a main effect and as part of the interaction term)

Multivariate analysis

CAUTION

If you have multiple versions of a variable (e.g. a continuous and a categorical age variable), you can only include one of them

Multivariate analysis

Step 2: Recheck confounders and effect modifiers

- Recheck confounders from bivariate analyses to see if they are still confounders of RF (10%-change-in-OR rule)
- Retest effect modifiers from trivariate analyses to see if they are still effect modifiers of RF (p<0.1)
- You have created your provisional model

Multivariate analysis

CAUTION

Note that in the presence of sparse cells, large changes in the OR may be indicative of model instability rather than confounding

Multivariate analysis

Step 3: Additional variables

- Consider variables that have not yet been tested multivariately
- Add these variables to the provisional model
- Determine if these variables now act as confounders of RF
- Determine if these variables now act as effect modifiers of RF

CAUTION

Variables included in an interaction must also be included as main effects

Multivariate analysis

Step 4: Scale

- Recheck the scale of all continuous model covariates
- Include correctly scaled variables in the model

Multivariate analysis

Step 5: Model stability

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- If everything looks OK, you have created your final model

Potential goal 3: To best predict the outcome

- Confounders and effect modifiers are only important if they improve the predictive ability of the model
- Note that the same univariate and multivariate analyses can be used as for potential goal 1
- However, you must check the predictive ability of your model and make changes if necessary

Univariate analysis

- Check scale of continuous variables
- Determine univariate significance ($p<0.25$) of each study variable

Multivariate analysis

Step 1: Initial main effects model

Include in the model

- Variables that were univariately significant at the 0.25 level
- Biologically important variables
- Known or suspected confounders
- Known or suspected effect modifiers

Multivariate analysis

CAUTION

If you have multiple versions of a variable (e.g. a continuous and a categorical age variable), you can only include one of them

Multivariate analysis

Step 2: Statistical significance and confounding

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- Return the variable to the model if it appears to be a confounder based on the 10%-change-in-OR rule
- Continue until all model covariates are biologically important, statistically significant ($p<0.05$) or confounders
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Multivariate analysis

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Multivariate analysis

Step 3: Additional variables

- Consider variables that have not yet been tested multivariately
- Add these variables to the provisional main effects model
- Determine whether these variables act as confounders or are statistically significant in the multivariate model ($p<0.05$)

Multivariate analysis

Step 4: Scale

- Recheck the scale of all continuous model covariates
- Include correctly scaled variables in the model
- You have created the final main effects model

Multivariate analysis

Step 5:Interactions

- Test significance of interactions between model covariates ($p<0.1$)
- Test significance of interactions between model covariates and "left out" variables ($p<0.1$)

Multivariate analysis

Step 6: Model stability

- Look for unreasonably large ORs or standard errors

Predictive ability of the model

- Evaluate predictive ability of the full model (see chapter 5)
- Remove least significant variable and check if the model still predicts the outcome well
- Return variable to the model if it appears to have an effect on the model's predictive ability
- Continue until all model covariates contribute to the predictive ability of the model

Predictive ability of the model

- Evaluate the effect of interactions on the predictive ability of the model
- Note that models containing different sets of variables may have similar predictive abilities