LOGISTIC REGRESSION

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OUT LINE

- Introduction to logistic regression
- Assumptions of logistic regression
- Steps in conducting logistic regression
- Advantages and Limitations of logistic regression
- Demonstration

Introduction: what is logistic regression

- A logistic regression model is a method used to model a data with dependent variable (out put data) that is categorical or binary.

Response variable

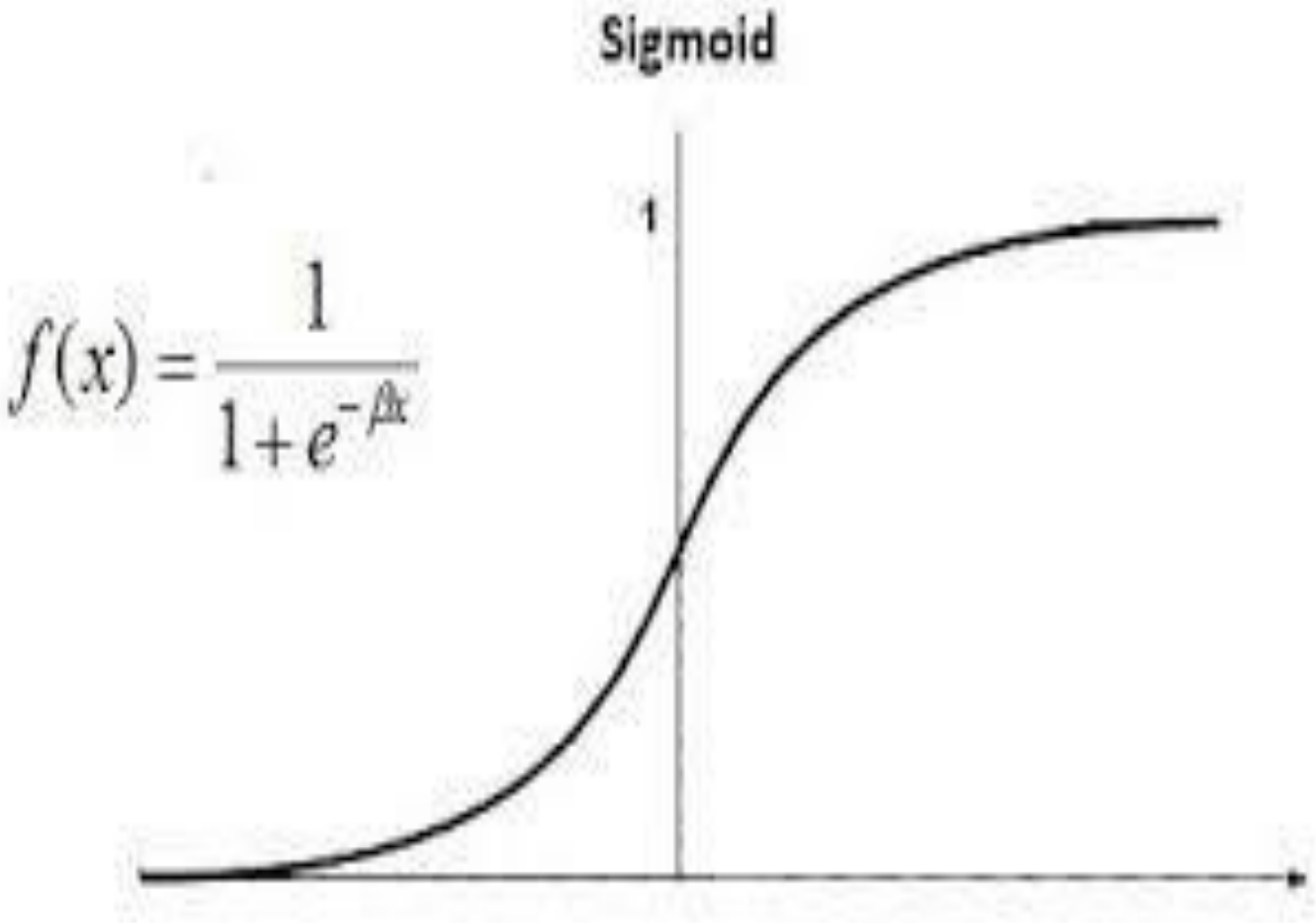
- ✓ Categorical
- ✓ one dependent variable

Logistic regression

Predictors(independent variables)

- ✓ Categorical or continuous
- ✓ one or more independent variables

Introduction: logistic regression



$$\log\left[\frac{P(x)}{1-P(x)}\right] = \beta_0 + \beta_1 x.$$

Introduction: logistic regression

Logistic regression

Binary logistic regression

- Number of categories are 2

Eg. Pass or fail

Ordinal logistic regression

- Number of categories are 3 or more

- Characteristics are at natural ordering of the level

Eg strongly agree, agree, neutral, disagree, strongly disagree

Nominal logistic regression

- Number of categories are 3 or more

- Characteristics are not as per at natural ordering of the level

Eg. Disease a, disease b, disease c

Assumptions in logistic regression

- The outcome variable should be categorical (binary, ordinal, nominal)
- The predictor or the independent variable can be continuous or categorical
- Assumes linearity of independent variables and log odds.
- Independent observations: the observations should not come from repeated measurements or matched data.

Assumptions in logistic regression

- logistic regression typically requires a large sample size.
- The model should provide a good fit to the data
- The correlation among the predictors(multi-collinearity) should not be severe.

Steps for conducting the binary logistic regression in SPSS

- Step 1 : Check the assumptions
- Step 2: conduct the univariate analysis
- Step 3: conduct the multivariate analysis
- Step 4: interpret the result

Step 1 : Check the assumptions

Model fit test

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	33.732	2	.000
	Block	33.732	2	.000
	Model	33.732	2	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	212.083[a]	.099	.186

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.205	1	.651

Omnibus test of model coefficients

- Statistical significance indicate good model fit

Model Summary: Nagelkerke R Square, which tells us the percentage of the variation in the response variable that can be explained by the predictor variables.

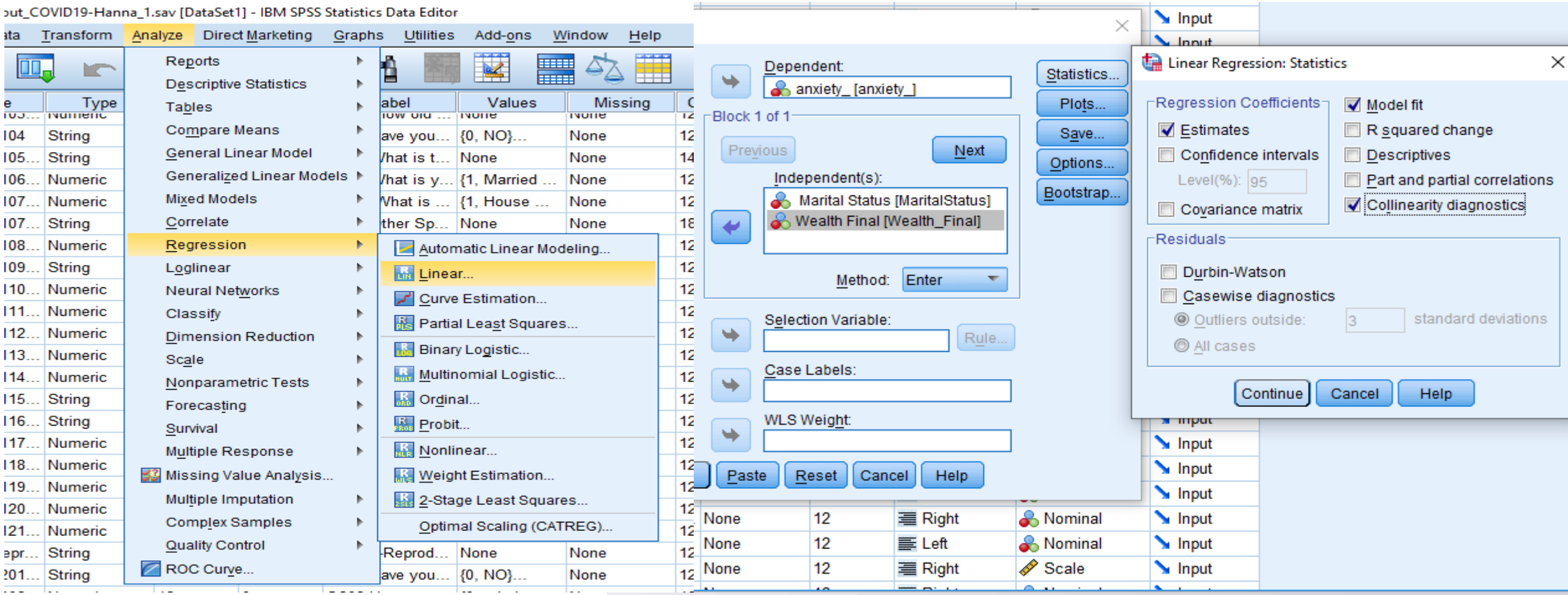
- In this case, wealth, marital status and age are able to explain 18.6% of the variability in anxiety disorder.

Hosmer and Lemeshow test

- Statistical significance indicate the model is not good fit for the data

Step 1 : Check the assumptions

- How to check **multi collinearity**



Step 1 : Check the assumptions

- How to check **multi collinearity**

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.312	.081		3.855	.000		
	Marital Status	.396	.074	.286	5.373	.000	.949	1.053
	Wealth Final	.120	.036	.178	3.341	.001	.949	1.053

a. Dependent Variable: anxiety_

How to perform logistic regression in SPSS

- **Step 2: conduct the univariate analysis**

Variables inclusion and selection

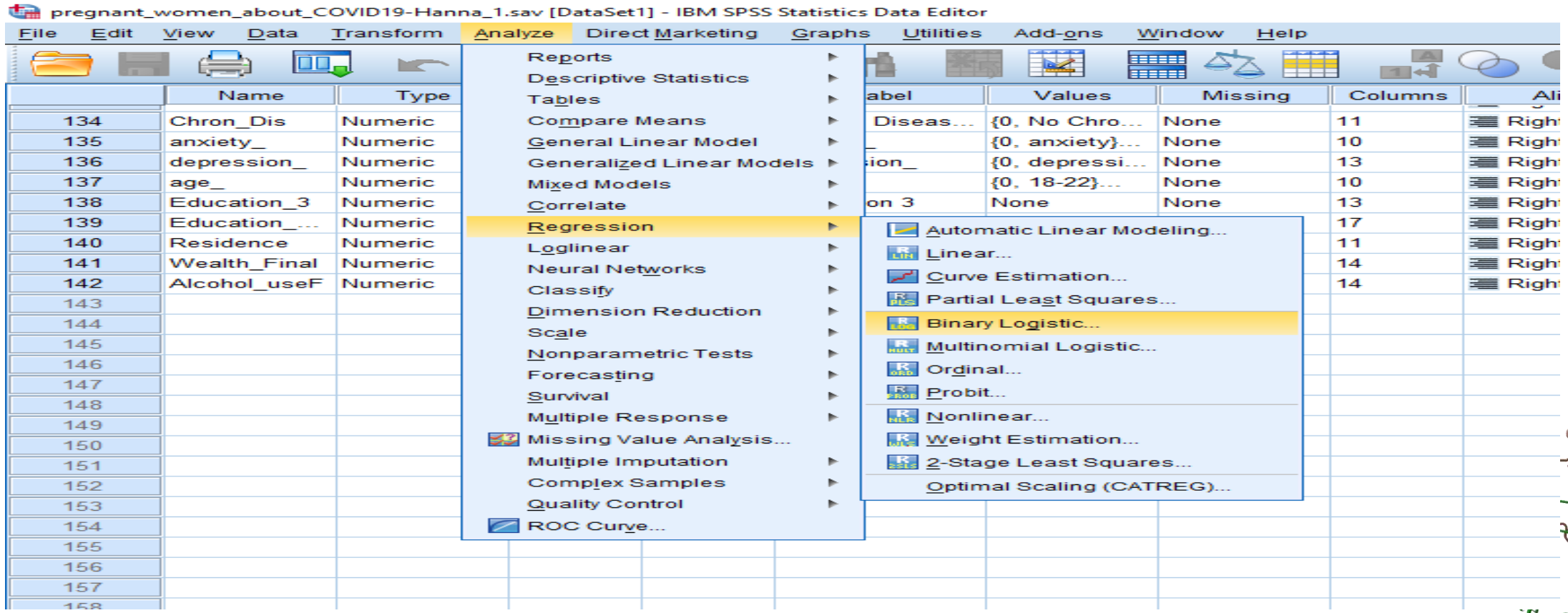
- limited sample size in relation to the number of candidate variables needs pre-selection
- test all variables previously, using models univariate models and include in the multivariate model all variables that have shown a relaxed P-value (for instance, $P \leq 0.25$).

Relaxed P-value criterion

- ✓ reduce the initial number of variables in the model
- ✓ reduce the risk of missing important variables

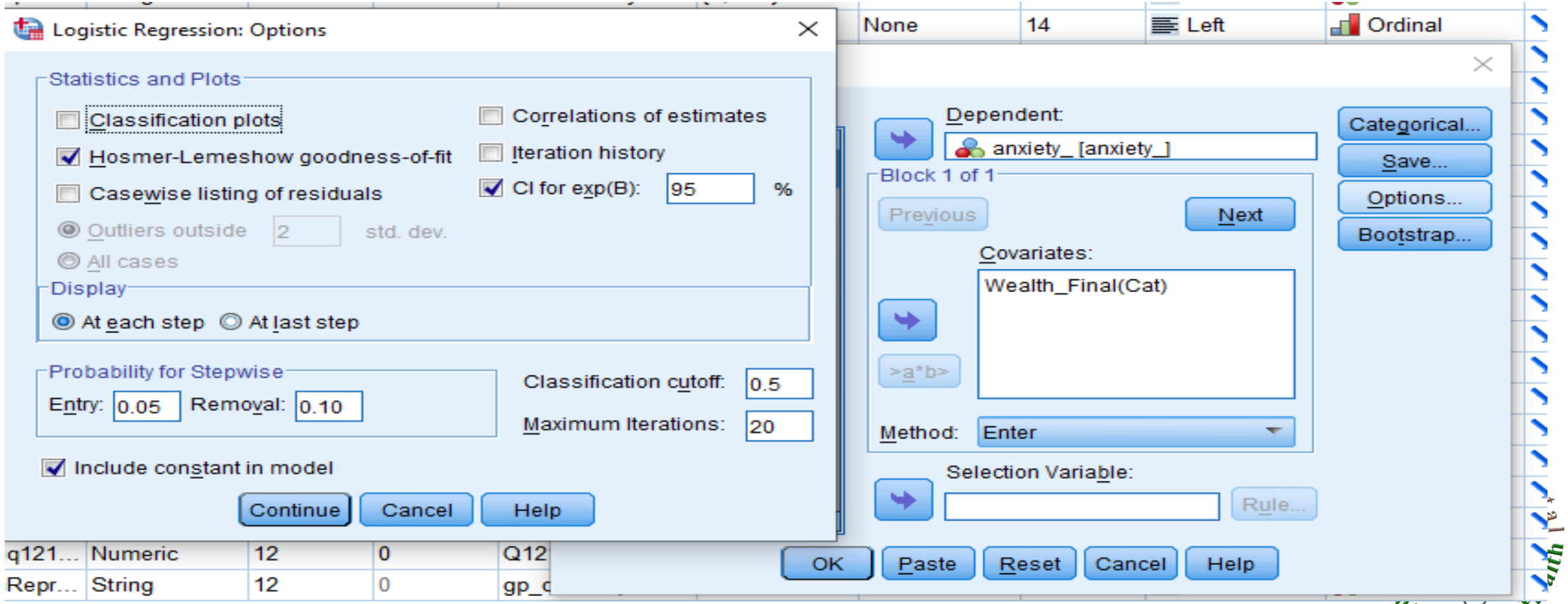
How to perform logistic regression in SPSS

- **Step 2: conduct the univariate analysis**
- Click the **Analyze** tab, then **Regression**, then **Binary Logistic Regression**:



How to perform logistic regression in SPSS

- **Step 2: conduct the univariate analysis**



How to perform logistic regression in SPSS

- **Step 2: conduct the univariate analysis**

a. The cut value is .500

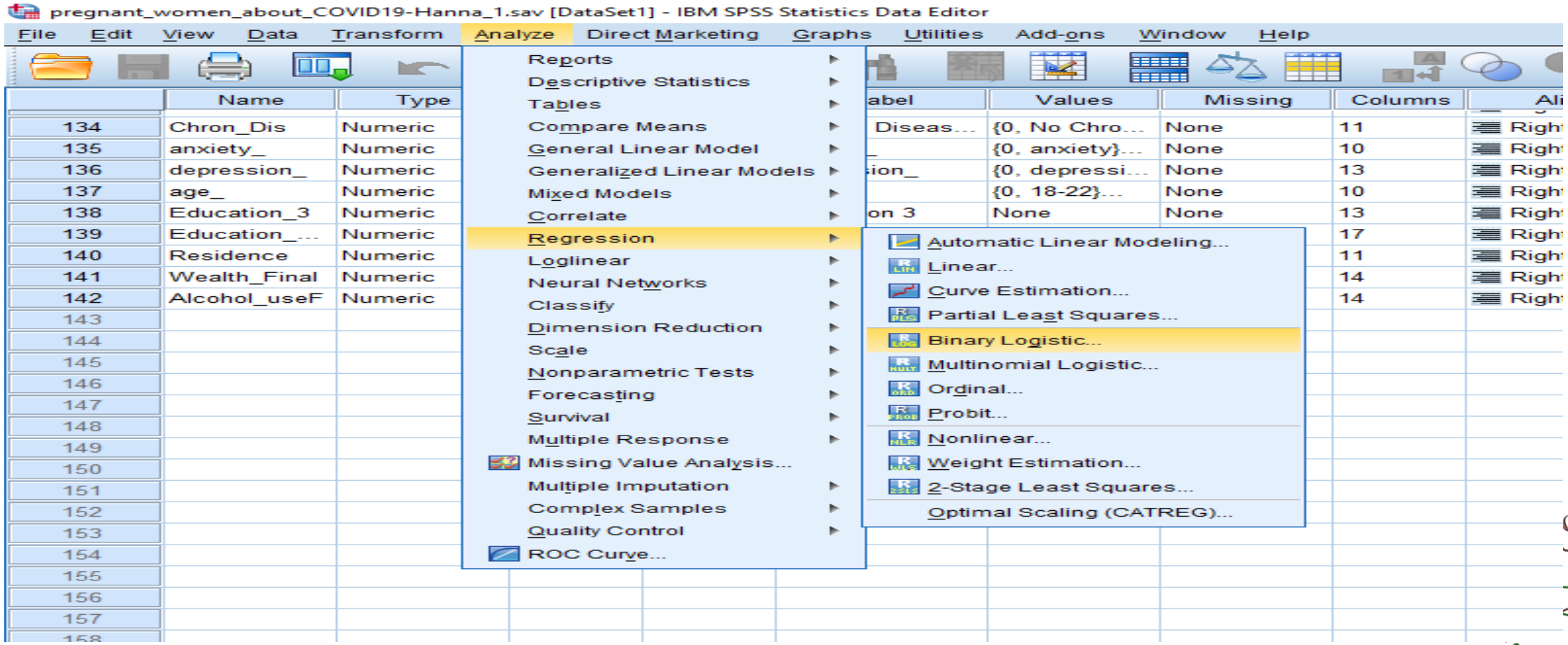
Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Wealth_Final(1)	1.525	.373	16.692	1	.000	4.597	2.212	9.557
	Constant	1.253	.207	36.620	1	.000	3.500		

a. Variable(s) entered on step 1: Wealth_Final.

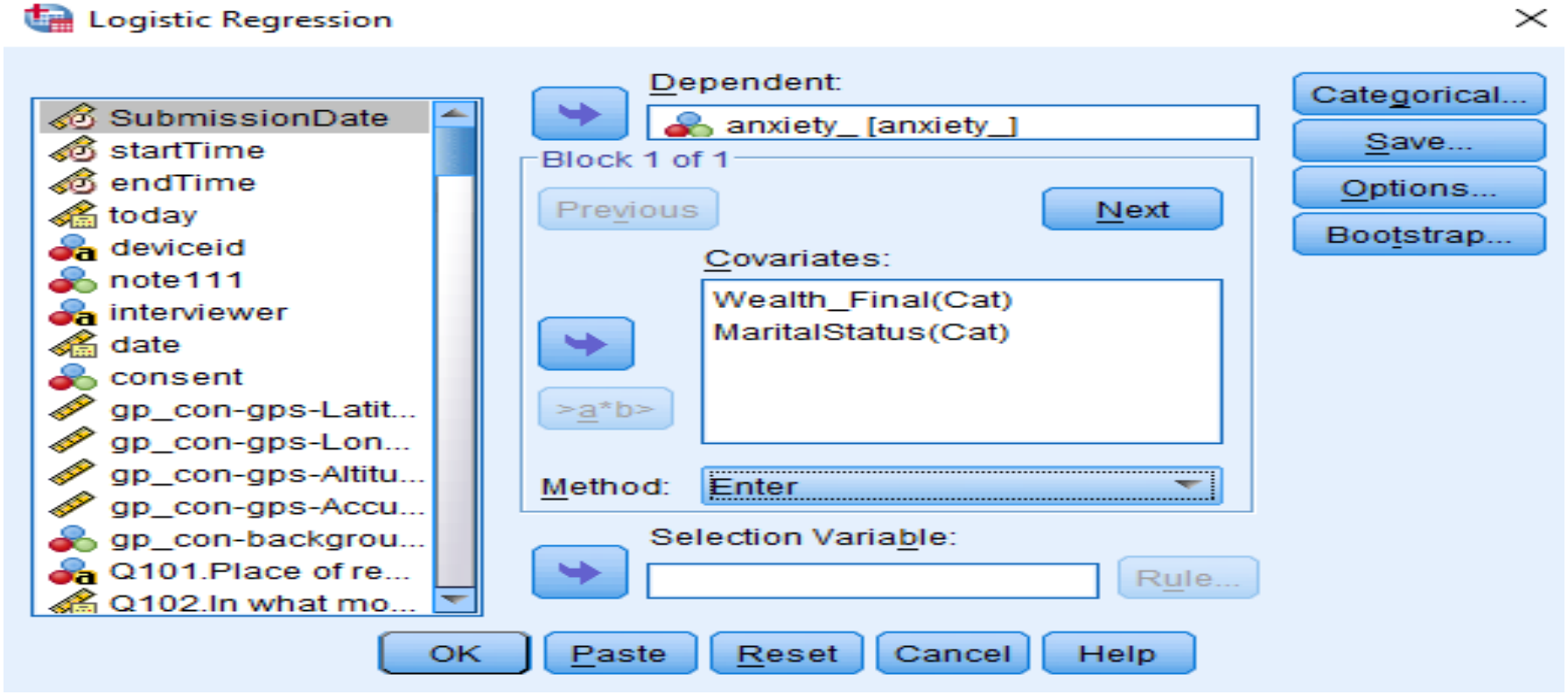
How to perform logistic regression in SPSS

- **Step 3: conduct the multivariate analysis**



How to perform logistic regression in SPSS

- **Step 3: conduct the multivariate analysis**
- In the new window that pops up, drag the binary response variable **ANXIETY** into the box labelled Dependent. Then drag the two predictor variables **wealth status** and **marital status** into the box labelled Block 1 of 1. Leave the **Method** set to Enter. Then click **OK**.



How to perform logistic regression in SPSS

Step 3: Interpret the out put

Classification Table[a]

Observed			Predicted		Percentage Correct
			anxiety_		
			anxiety	no anxiety	
Step 1	anxiety_	anxiety	9	32	22.0
		no anxiety	8	274	97.2
	Overall Percentage				87.6

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	gp_conq103age	-.010	.039	.072	1	.788	.990	.917	1.068
	Wealth_Final(1)	1.246	.390	10.197	1	.001	3.478	1.618	7.474
	MaritalStatus(1)	1.998	.513	15.184	1	.000	7.371	2.699	20.134
	Constant	-.114	1.109	.011	1	.918	.892		

a. Variable(s) entered on step 1: gp_conq103age, Wealth_Final, MaritalStatus.

What does the boxes indicate

Classification Table: Overall Percentage, which tells us the percentage of observations that the model was able to classify correctly.

Variables in the Equation:

- **Wald:** is used to determine whether or not each predictor variable is statistically significant.
- **Sig:** The p-value that corresponds to the Wald test statistic for each predictor variable.
  - p-value for **wealth** is .001 and the p-value for **marital status** is .0001.
- **Exp(B):** The odds ratio for each predictor variable. This tells us the change in the odds of a pregnant mother getting anxiety disorder associated with an increase in a given predictor variable.

Step 4: interpret the result

Example : report

- Logistic regression was performed to determine how wealth status, marital status and age affect a pregnant mothers probability of getting anxiety disorder. A total of 323 pregnant mothers were used in the analysis.
- The model explained 18.6**%** of the variation in anxiety disorder due to this predictors and correctly classified **87.6%** of cases.
- We can use the coefficients (the values in the column labeled B) or the odds ratio(the values in the column labeled Exp(B)) to predict the probability that a pregnant women will get anxiety disorder.

Step 4: interpret the result

- ✓ The odds of anxiety disorder in a pregnant women who are single is 7.25 times higher compared to the married pregnant women keeping other variables constant.
- ✓ The odds of anxiety disorder in a pregnant women who are in low wealth status is 3.5 times higher compared to the high wealth status pregnant women keeping other variables constant.
- ✓ For each increment of age there is decrement of anxiety disorder by 0.005times or 0.01% keeping others constant(but the p >0.05 so no need to interpret this variable)

Variables in the Equation

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a. Variable(s) entered on step 1: gp_conq103age, Wealth_Final, MaritalStatus.

Advantages of logistic regression

- It does not only provides a measure of how appropriate a predictor (coefficient size) is, but also its direction of association (positive or negative).
- Good accuracy for many simple data sets and it performs well when the dataset is linearly separable.
- It can easily extend to multiple classes(multinomial regression) and a natural probabilistic view of class predictions.
- It makes no assumptions about distributions of classes.
- Logistic regression is easier to implement, interpret, and efficient to train

Limitations of logistic regression

- If the number of observations is lesser than the number of features, Logistic Regression should not be used, otherwise, it may lead to overfitting.
- It can only be used to predict discrete functions.
- Non-linear problems can’t be solved with logistic regression because it has a linear decision surface.
- Logistic Regression requires average or no multi collinearity between independent variables

- Demonstration with SPSS

Summary

- logistic regression model is a method used to model a data with dependent variable that is categorical or binary.
- Check the assumptions of logistic regression.
- Conduct the bivariate and multivariate analysis and interpret.

Reference

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- Bujang MA, Sa'at N, Sidik TMITAB, Joo LC. Sample Size Guidelines for Logistic Regression from Observational Studies with Large Population: Emphasis on the Accuracy Between Statistics and Parameters Based on Real Life Clinical Data. Malays J Med Sci. 2018 Jul;25(4):122–30.
- Sperandei S. Understanding logistic regression analysis. Biochem Med (Zagreb). 2014 Feb 15;24(1):12–8.
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Thank you