羅吉斯迴歸分析

醫學研究部 醫學研究部 生統小組

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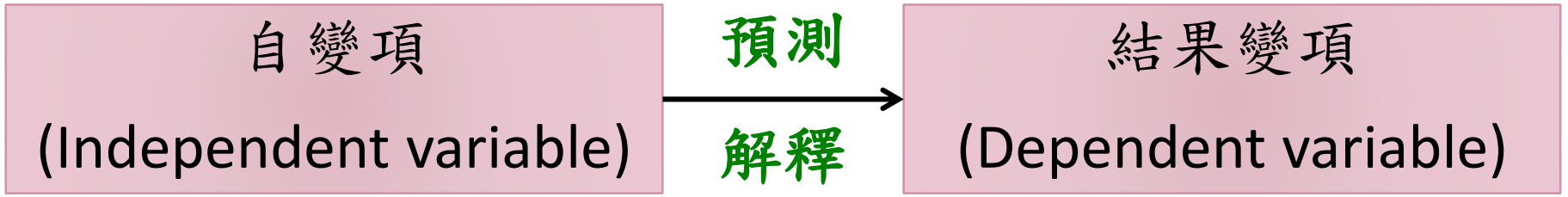
2024/11/26

內容大綱

- 單變數與多變數迴歸 (危險對比值odds ratio)
- ROC分析及找切點

Logistic regression



- Dependent variable
  - Binary - 0 & 1
- Independent variable
  - Categorical / Continuous

預測 1 的機率

Logistic regression

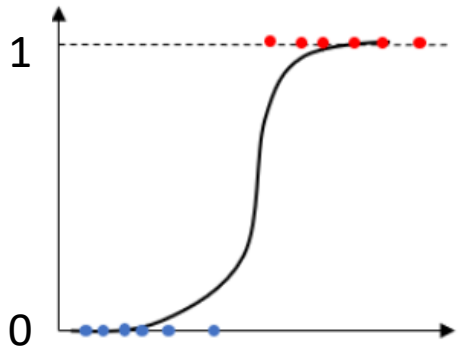
- 單變項迴歸

$$\ln\frac{p}{1-p} = \beta_0 + \beta_1 X_1$$

- 多變項迴歸

$$\ln\frac{p}{1-p} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_k X_k$$

- 不需要常態分配的假設
  - 自變數 (X) 對依變數 (Y) -指數的方式做變動
- 參數估計
  - 最大概似函數估計法 (Maximum Likelihood Estimation)



Odds ratio (OR)

相關強度

預測 1 的機率

		Outcome (Disease)	
		Yes	No
Exposed	Yes	a	b
	No	c	d

$$\text{Odds ratio (OR)} = \frac{a/b}{c/d} = \frac{ad}{bc}$$

- OR = 1, No association
- OR > 1, Positive association (possibly causal)
- OR < 1, Negative association (possibly protective)

		1-year mortality or 14-day readmission	
		Yes	No
Cardiovascular disease	Yes	15	91
	No	5	156

$$\text{Odds ratio (OR)} = \frac{15*156}{91*5}$$

$$= \frac{2340}{455}$$

$$= 5.14$$

TABLE 3 | Predictors of 1-year mortality or 14-day readmission outcome in patients with PAC.

	Simple model	Model 1
	OR (95% CI)	**OR (95% CI)**
Age	1.05 (1.01–1.09)*	1.01 (0.98–1.05)
Female vs. male	0.76 (0.28–2.05)	
BMI	0.77 (0.66–0.90)**	0.74 (0.62–0.89)**
Cardiovascular disease	5.14 (1.81–14.62)**	4.90 (1.46–16.41)*

Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

Logistic regression

Example.1

TABLE 3 | Predictors of 1-year mortality or 14-day readmission outcome in patients with PAC.

	Simple model	Model 1	Model 2
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.05 (1.01–1.09)*	1.01 (0.98–1.05)	1.01 (0.97–1.05)
Female vs. male	0.76 (0.28–2.05)		
BMI	0.77 (0.66–0.90)**	0.74 (0.62–0.89)**	0.74 (0.62–0.89)**
Cardiovascular disease	5.14 (1.81–14.62)**	4.90 (1.46–16.41)*	6.36 (1.82–22.19)**
ACCI	1.16 (0.95–1.42)		
Improved functional numbers	0.65 (0.54–0.79)**	0.69 (0.55–0.86)**	
Improved functional numbers (≥5 vs. <5)	0.12 (0.04–0.31)**		0.16 (0.05–0.45)**

探討【1-year mortality or 14-day readmission】影響因子

Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

Logistic regression

SPSS dataset

Outcome
(0 / 1)

	NO	Y1	age	sex
1	1	0	64	2
2	2	0	83	2
3	3	0	61	1
4	4	0	79	2
5	5	0	79	2
6	6	0	93	2
7	7	0	60	1
8	8	0	67	1
9	9	0	67	2
10	10	0	66	2
11	11	0	32	2
12	12	1	86	1
13	13	0	72	2

Data View | Variable View

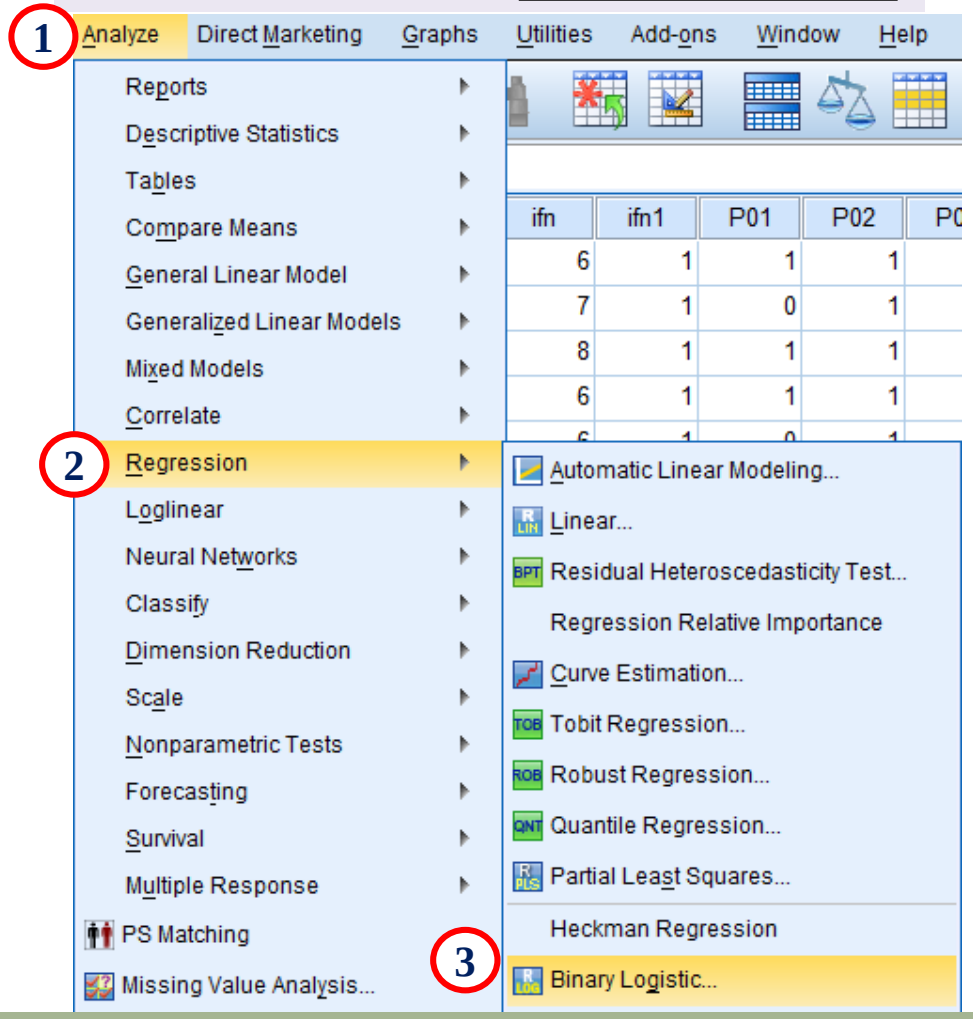
	Name	Type	Width	Decimals	Label	Values
1	NO	Numeric	8	0		None
2	Y1	Numeric	8	0	1-year mortality or 14-day readmission outcome	{0, No}...
3	age	Numeric	8	0	Age	None
4	sex	Numeric	8	0	Sex	{1, Male}...
5	bmi	Numeric	8	0	BMI	None
6	cvd	Numeric	8	0	Cardiovascular disease	{0, No}...
7	acci	Numeric	8	0	ACCI	None
8	ifn	Numeric	8	0	Improved functional numbers	None
9	ifn1	Numeric	8	0	Improved functional numbers (≥ 5 vs. < 5)	{0, No}...
10	P01	Numeric	8	0	Improved funtionality_MRS	{0, No}...
11	P02	Numeric	8	0	Improved funtionality_ADLs	{0, No}...
12	P03	Numeric	8	0	Improved funtionality_IADLs	{0, No}...
13	P04	Numeric	8	0	Improved funtionality_FOIS	{0, No}...

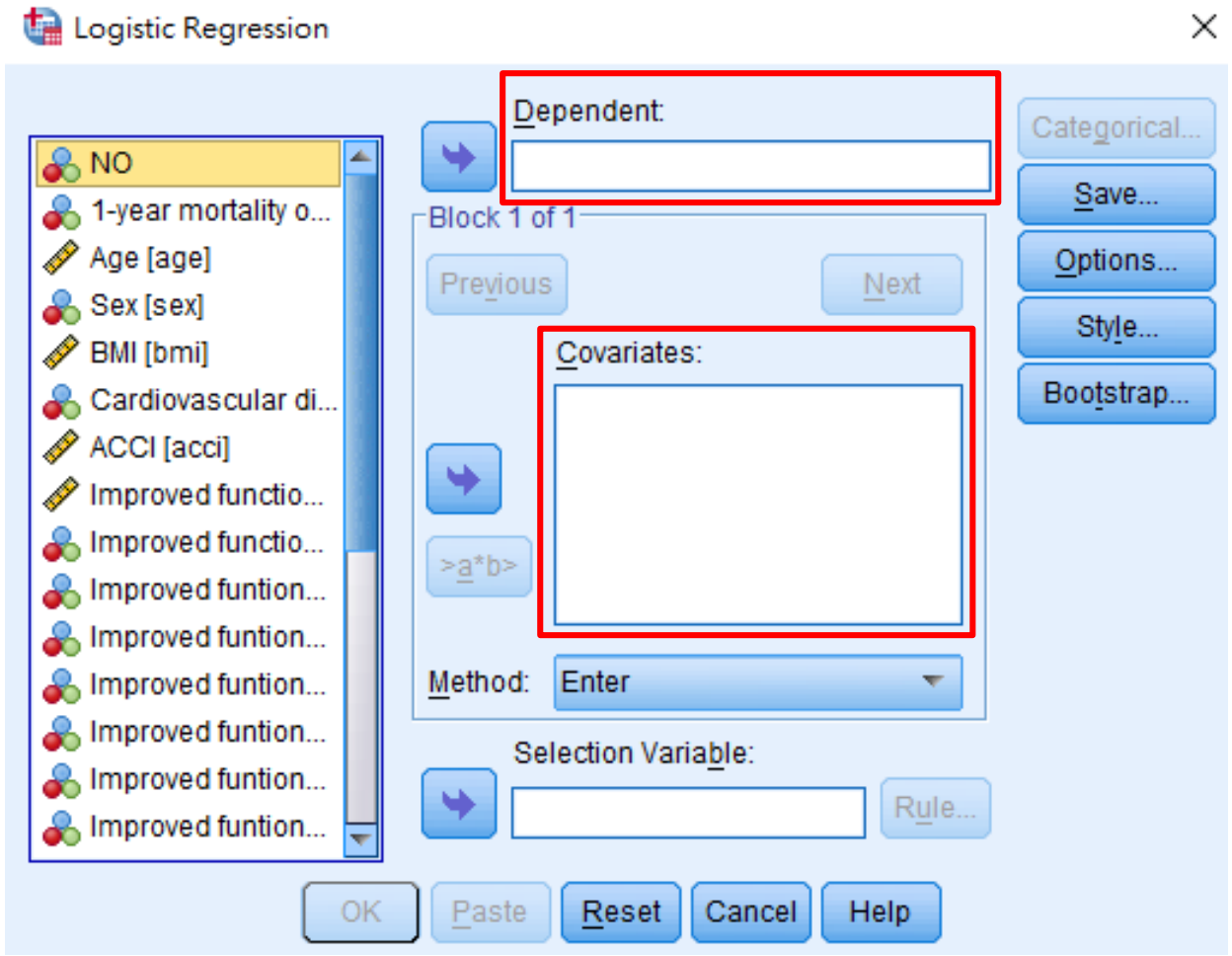
Data View | Variable View

Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

Logistic regression

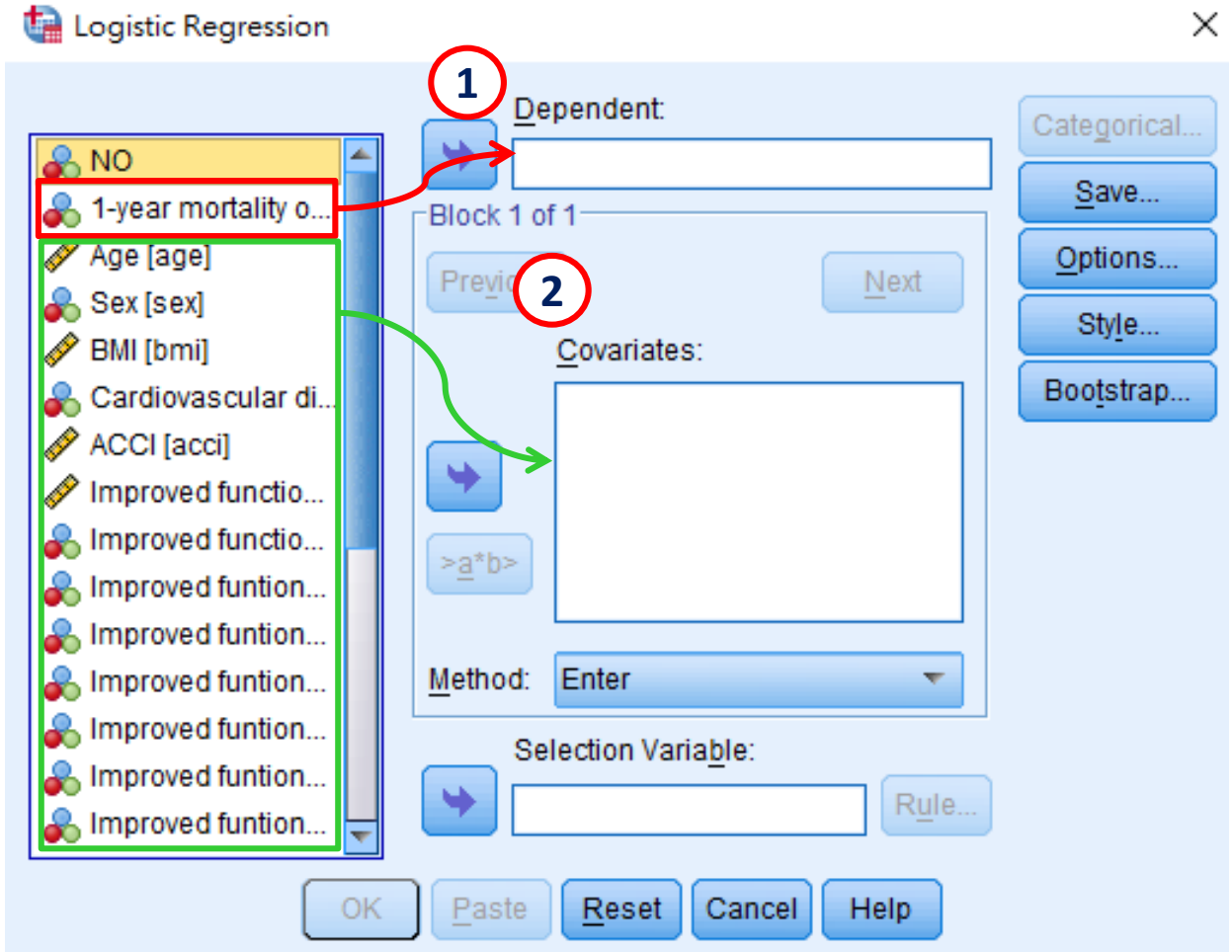
分析→迴歸→二元Logistic

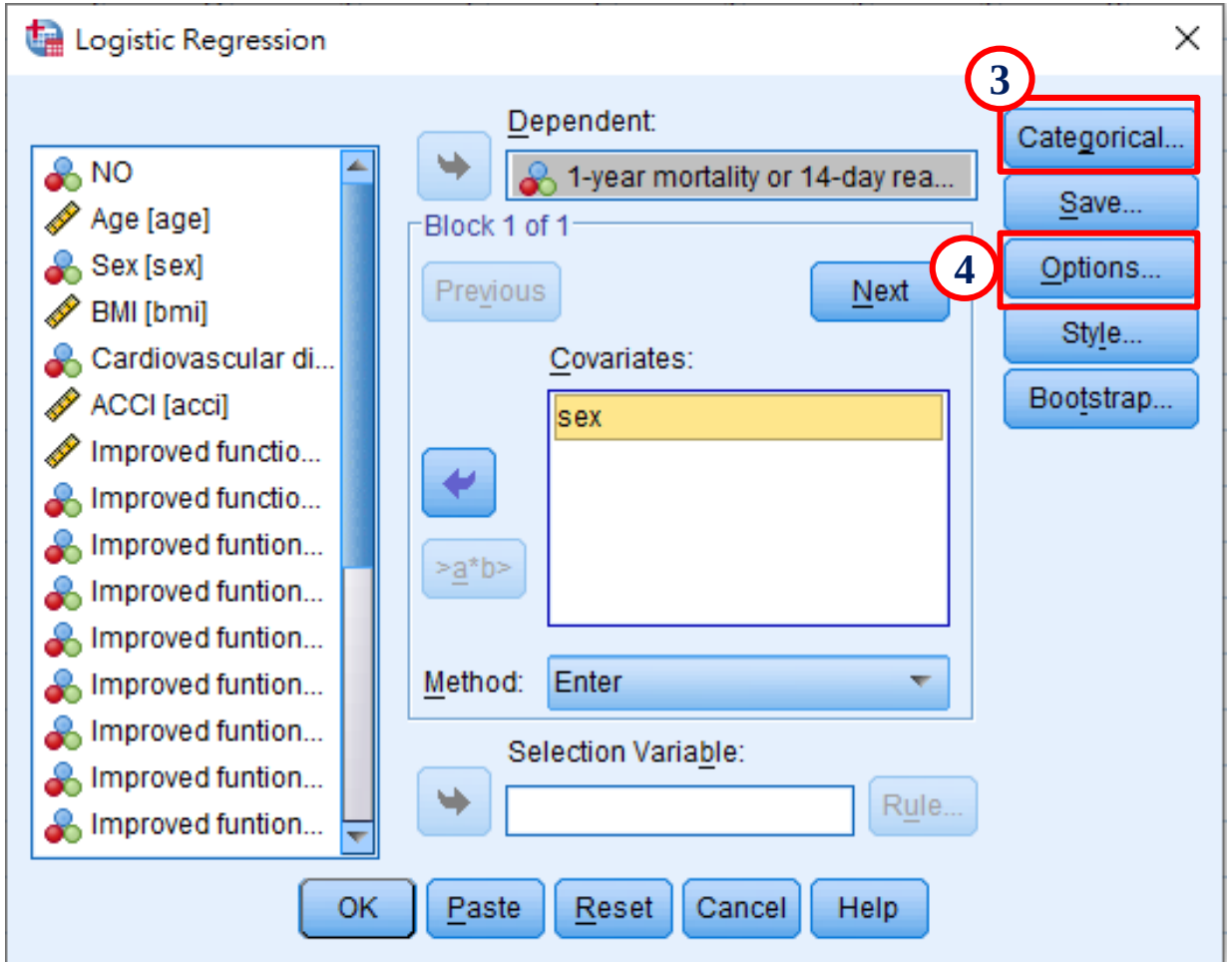




Logistic regression

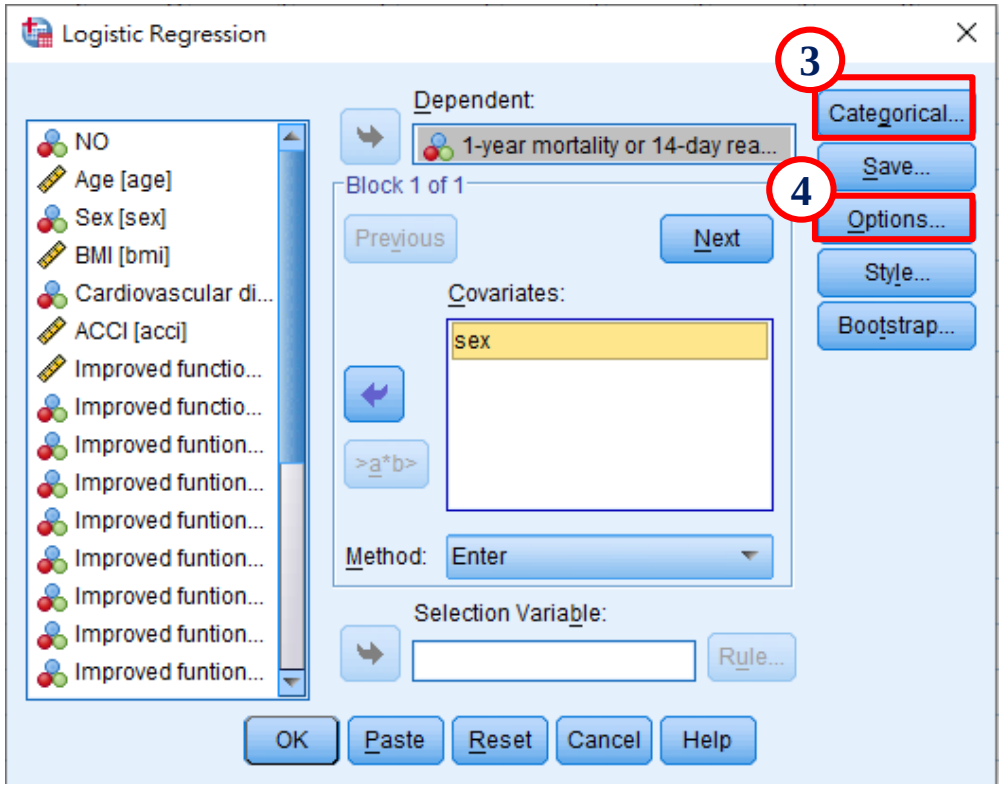
分析→迴歸→二元Logistic

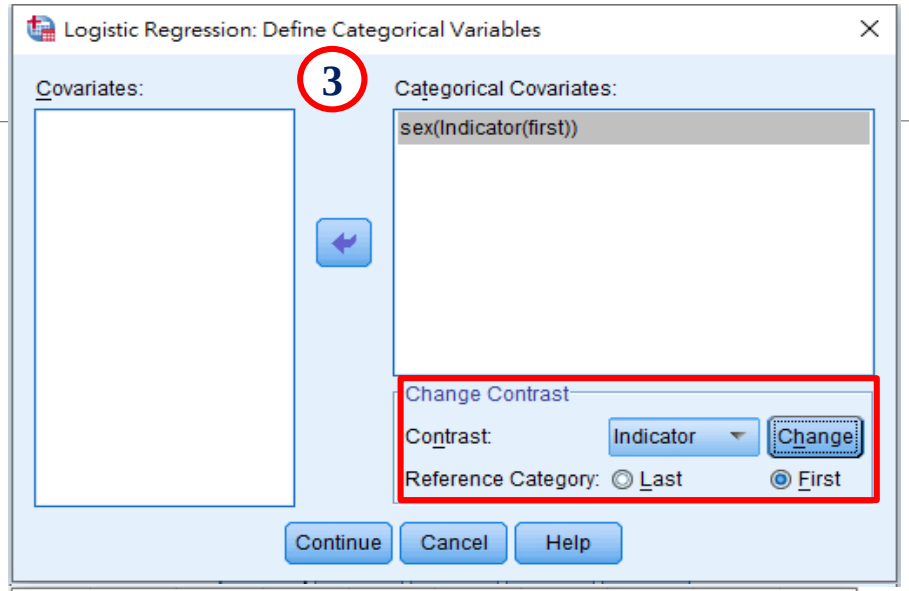


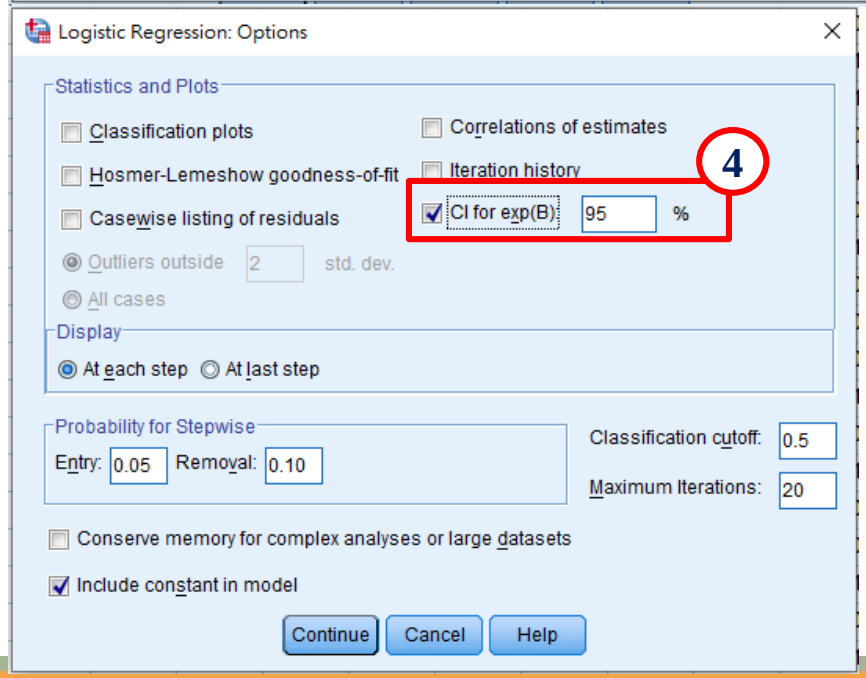


Logistic regression

分析→迴歸→二元Logistic







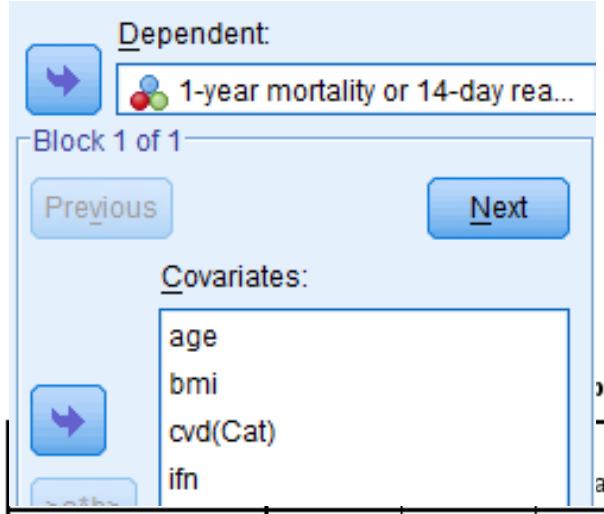
Logistic regression (SPSS output)

Variables in the Equation

OR

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	sex(1)	-.273	.506	.292	1	.589	.761	.282	2.050
	Constant	-2.424	.279	75.536	1	.000	.089		

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



Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	age	.014	.020	.502	1	.478	1.014	.975	1.055
	bmi	-.297	.093	10.151	1	.001	.743	.619	.892
	cvd(1)	1.589	.617	6.631	1	.010	4.898	1.462	16.414
	ifn	-.372	.112	11.051	1	.001	.689	.553	.858
	Constant	4.344	2.648	2.692	1	.101	77.039		

a. Variable(s) entered on step 1: age, bmi, cvd, ifn.

	Simple model
	OR (95% CI)
Female vs. male	0.76 (0.28–2.05)

	Model 1
	OR (95% CI)
Age	1.01 (0.98–1.05)
Female vs. male	
BMI	0.74 (0.62–0.89)**
Cardiovascular disease	4.90 (1.46–16.41)*
ACCI	
Improved functional numbers	0.69 (0.55–0.86)**

Adjusted age, BMI, CVD, 評估指標進步項目每增加一項，一年內死亡或14天再入院的風險降低0.69倍 (減少31%) (p = 0.001)

Logistic regression

Example.2

探討【憂鬱症】
影響因子

Table 5 Logistic regression analysis of factors associated with depression

Factors	Univariate				Multi			
	OR	95%CI		*p* value	OR	95%CI		*p* value
Age	0.95	(0.90-	1.01)	0.084	0.96	(0.90-	1.03)	0.279
Sex (male vs. female)	0.59	(0.19-	1.86)	0.365	0.92	(0.20-	4.30)	0.912
PSQI > 13	9.67	(2.56-	36.52)	0.001**	7.06	(1.37-	36.50)	0.020*
THI-CM > 47	12.83	(3.46-	47.65)	< 0.001**	7.43	(1.73-	32.02)	0.007**

*$p < 0.05$, **$p < 0.01$. OR, odds ratio; CI, confidence interval; **Depression, Patient Health Questionnaire-9 ≥ 10** ; PSQI, Pittsburgh Sleep Quality Index; THI-CM, Chinese-Mandarin version of the Tinnitus Handicap Inventory

Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

Logistic regression

SPSS dataset

Outcome
(0 / 1)

	NO	dep	age	sex	psq1	tin1	psq	tin
1	65	1	73	1	0	0	11	14
2	47	0	66	0	0	0	3	14
3	43	0	50	0	0	0	4	12
4	34	0	61	1	0	0	4	12
5	12	0	64	0	0	0	9	12
6	4	0	51	1	0	0	6	10
7	30	0	25	1	0	0	4	10
8	31	0	26	0	0	0	8	10
9	13	0	70	1	0	0	5	8
10	42	1	40	1	0	0	1	6
11	24	0	68	1	0	0	13	4
12	23	0	57	1	0	0	11	4
13	26	0	60	1	0	0	4	4

Data View | Variable View

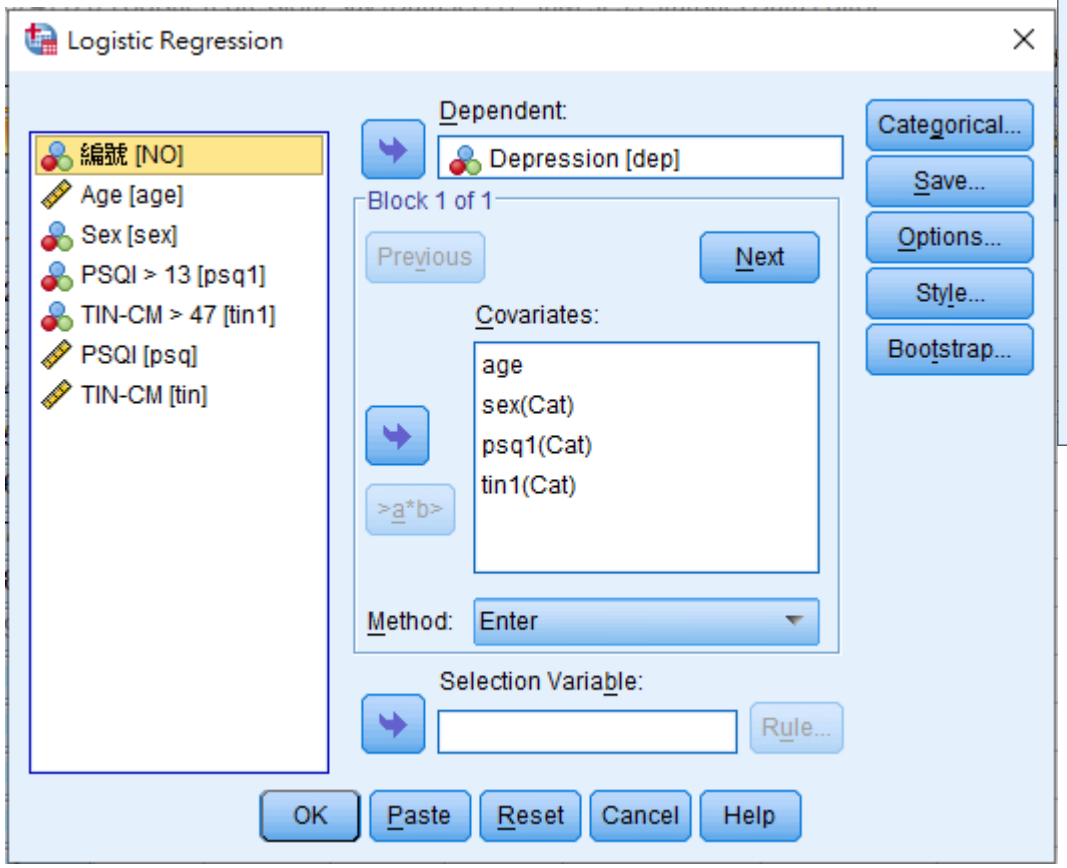
	Name	Type	Width	Decimals	Label	Values
1	NO	Numeric	11	0	編號	None
2	dep	Numeric	8	0	Depression	{0, No}...
3	age	Numeric	8	0	Age	None
4	sex	Numeric	8	0	Sex	{0, Female}...
5	psq1	Numeric	8	0	PSQI > 13	{0, No}...
6	tin1	Numeric	8	0	TIN-CM > 47	{0, No}...
7	psq	Numeric	8	0	PSQI	None
8	tin	Numeric	8	0	TIN-CM	None
9						
10						
11						
12						
13						
14						

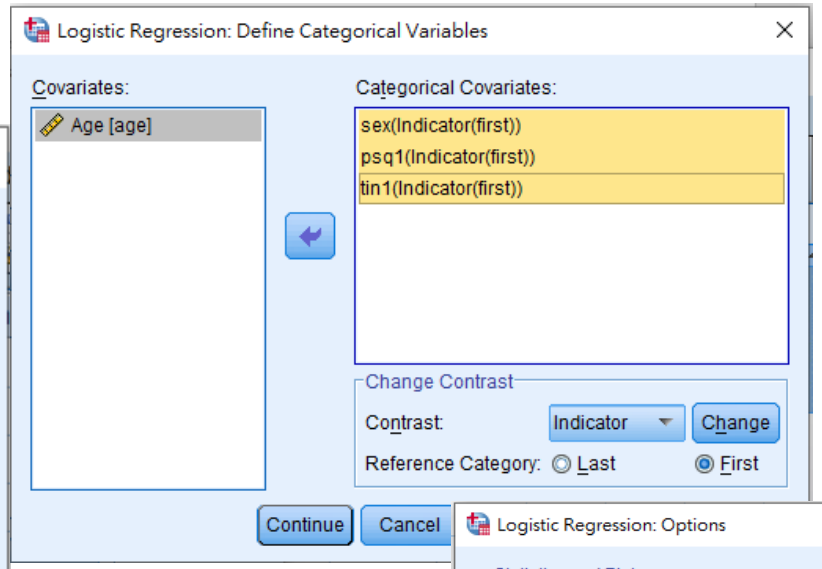
Data View | Variable View

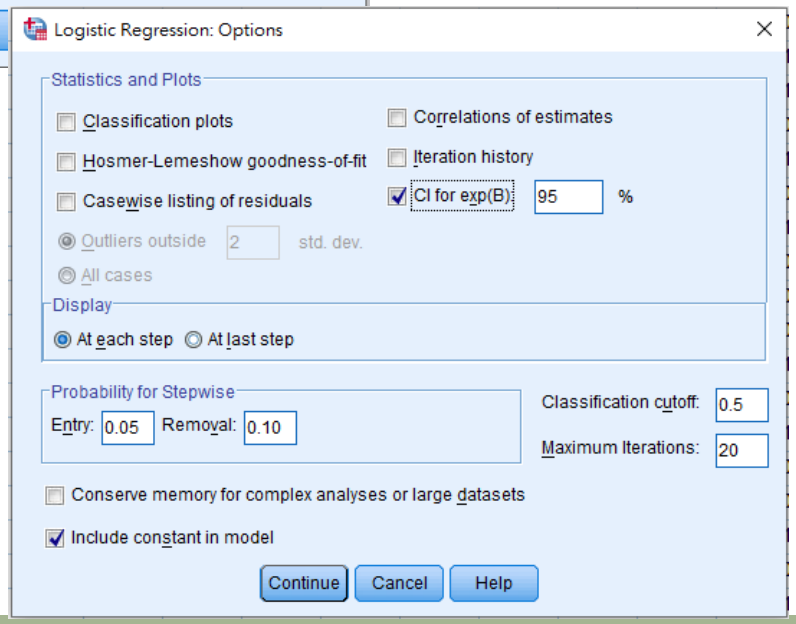
Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

Logistic regression

分析→迴歸→二元Logistic







Logistic regression (SPSS output)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	age	-.039	.036	1.172	1	.279	.962	.896	1.032
	sex(1)	-.088	.789	.012	1	.912	.916	.195	4.302
	psq1(1)	1.955	.838	5.444	1	.020	7.064	1.367	36.501
	tin1(1)	2.006	.745	7.248	1	.007	7.433	1.726	32.016
	Constant	-.104	1.936	.003	1	.957	.901		

a. Variable(s) entered on step 1: age, sex, psq1, tin1.

OR

Adjusted age, sex, PSQI scores >13,
THI-CM scores > 47比 ≤ 47，
有7.4倍憂鬱症的風險。(p = 0.007)

Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

Multinomial Logistic regression

Example

Table 4 Multinomial logistic regression of factors associated with **THI-CM categorical**

	Univariate							Adjusted for Obstructive sleep apnoea							
	Grade2 vs. Grade1				Grade3-5 vs. Grade1				Grade2 vs. Grade1				Grade3-5 vs. Grade1			
	OR	(95%CI)		*p* value	OR	(95%CI)		*p* value	OR	(95%CI)		*p* value	OR	(95%CI)		*p* value
Male	0.95	(0.24-	3.75)	0.944	0.74	(0.20-	2.79)	0.657								
Age	1.04	(0.97-	1.11)	0.273	0.98	(0.92-	1.04)	0.466								
BMI (kg/m^2)	1.07	(0.91-	1.25)	0.418	1.07	(0.91-	1.25)	0.409								
Neck circumference (cm)	1.09	(0.95-	1.25)	0.204	0.97	(0.84-	1.12)	0.674								
Waist circumference (cm)	1.02	(0.96-	1.08)	0.509	1.01	(0.96-	1.07)	0.601								
PHQ-9 (total score)	1.07	(0.90-	1.28)	0.449	1.37	(1.13-	1.66)	0.001**	1.00	(0.82-	1.22)	0.996	1.28	(1.04-	1.56)	0.017*
Depression	1.31	(0.37-	4.64)	0.676	16.43	(2.89-	93.41)	0.002**	0.70	(0.15-	3.18)	0.640	8.68	(1.19-	63.32)	0.033*
Obstructive sleep apnoea	3.33	(0.78-	14.14)	0.104	16.80	(1.82-	154.89)	0.013*								
Subjective sleep quality	1.92	(0.78-	4.70)	0.155	6.15	(2.09-	18.04)	0.001**								
Sleep latency	0.96	(0.49-	1.88)	0.912	1.69	(0.86-	3.32)	0.126								
Sleep duration	1.11	(0.57-	2.17)	0.753	1.95	(0.95-	4.01)	0.069								
Habitual sleep efficiency	1.66	(0.80-	3.44)	0.172	2.14	(1.05-	4.36)	0.037*								
Sleep disturbances	4.54	(1.35-	15.22)	0.014*	6.72	(1.95-	23.22)	0.003**								
Use of sleep medication	1.80	(1.10-	2.95)	0.019*	1.93	(1.19-	3.16)	0.008**								
Daytime dysfunction	2.58	(1.08-	6.19)	0.034*	3.78	(1.55-	9.26)	0.004**								
Apnea–Hypopnea Index	1.01	(0.98-	1.05)	0.525	1.00	(0.97-	1.04)	0.799								
Apnea–Hypopnea Index > 5	1.18	(0.29-	4.78)	0.816	1.32	(0.33-	5.29)	0.696								

. *p < 0.05, **p < 0.01. Depression defined by PHQ-9 ≥ 10. PHQ-9, Patient Health Questionnaire-9

Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

Multinomial Logistic regression

- Dependent variable
  - Nominal level (> 2 groups)
- Independent variable
  - Categorical / Continuous

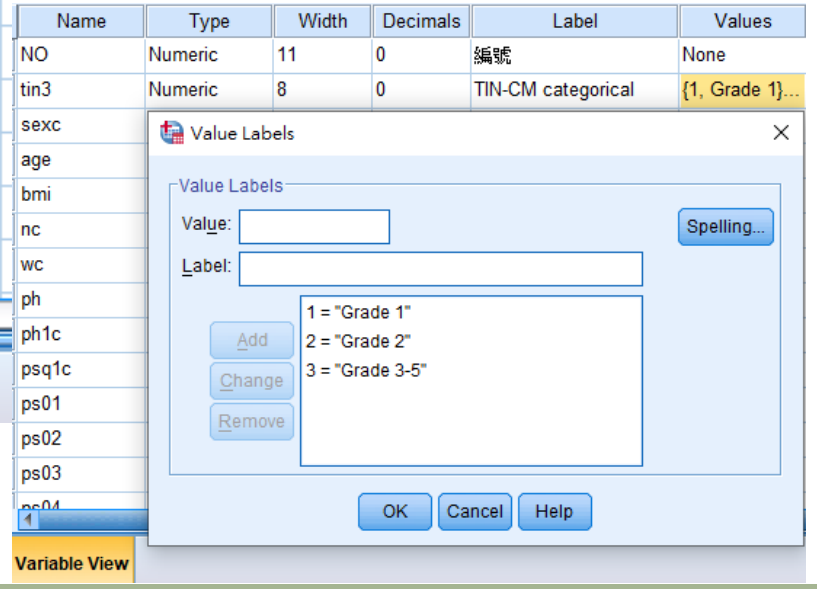
Multinomial Logistic regression

SPSS dataset

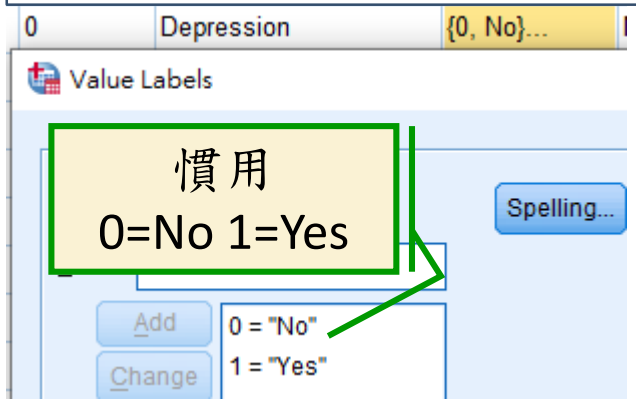
	NO	tin3	sexc	age
1	1	2	0	55
2	2	2	1	59
3	3	2	0	61
4	4	1	0	51
5	5	3	0	46
6	6	2	0	59
7	7	2	0	52
8	8	3	1	60
9	9	2	0	59
10	10	3	0	49
11	11	2	1	37
12	12	1	1	64

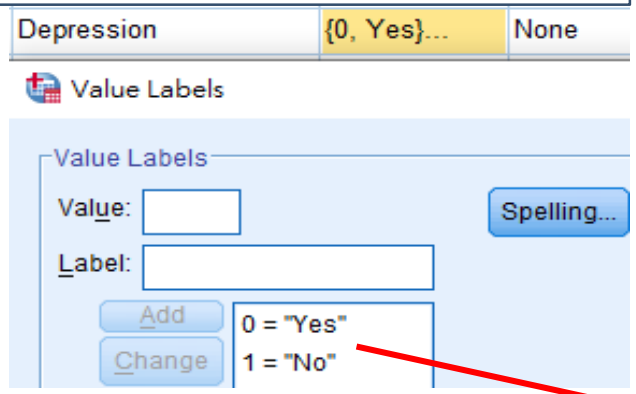
Data View | Variable View

Dependent
(1 / 2 / 3)



Independent variable





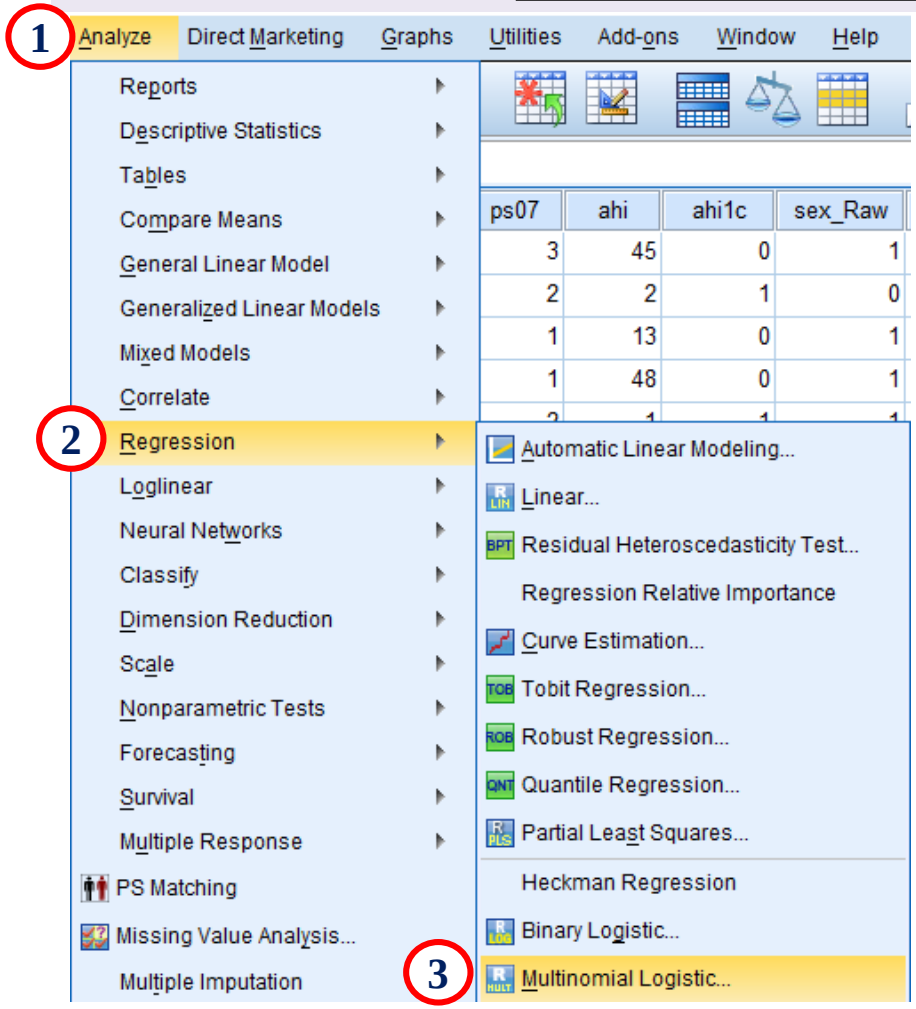
Multinomial Logistic

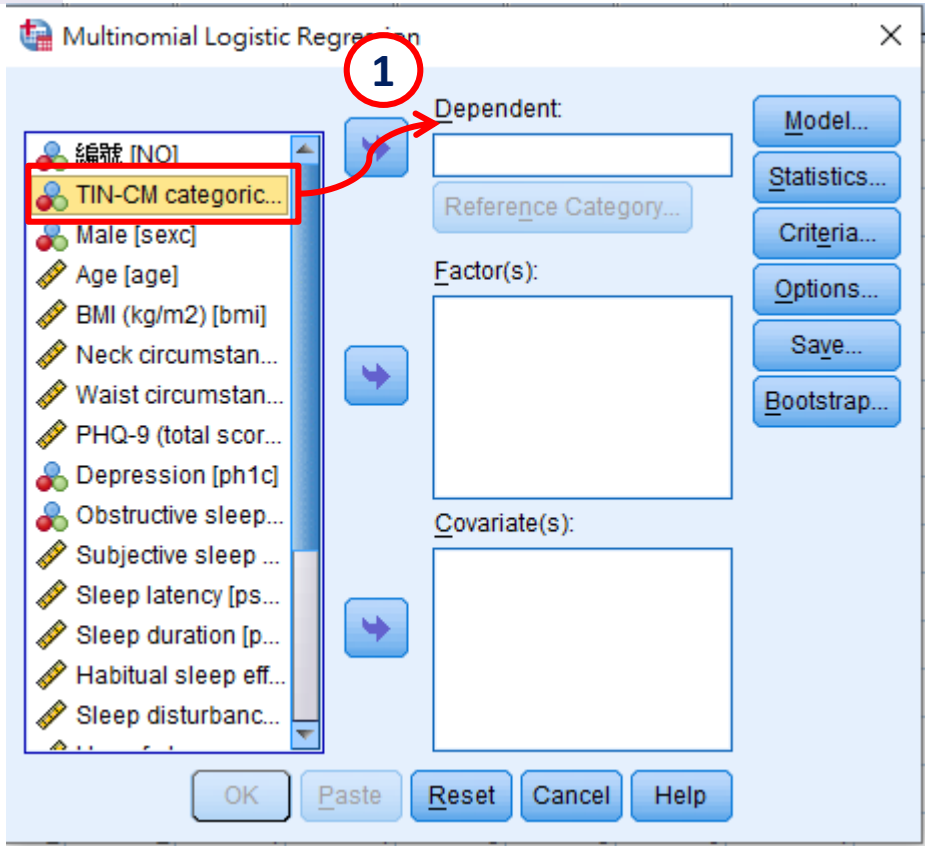
- Independent (**Categorical**)
  - > **Reference** (預設「數值大」)
    - 0 (Yes) vs **1** (No)
    - 1 (Yes) vs **2** (No)

Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

Multinomial Logistic regression

分析→迴歸→多項式Logistic





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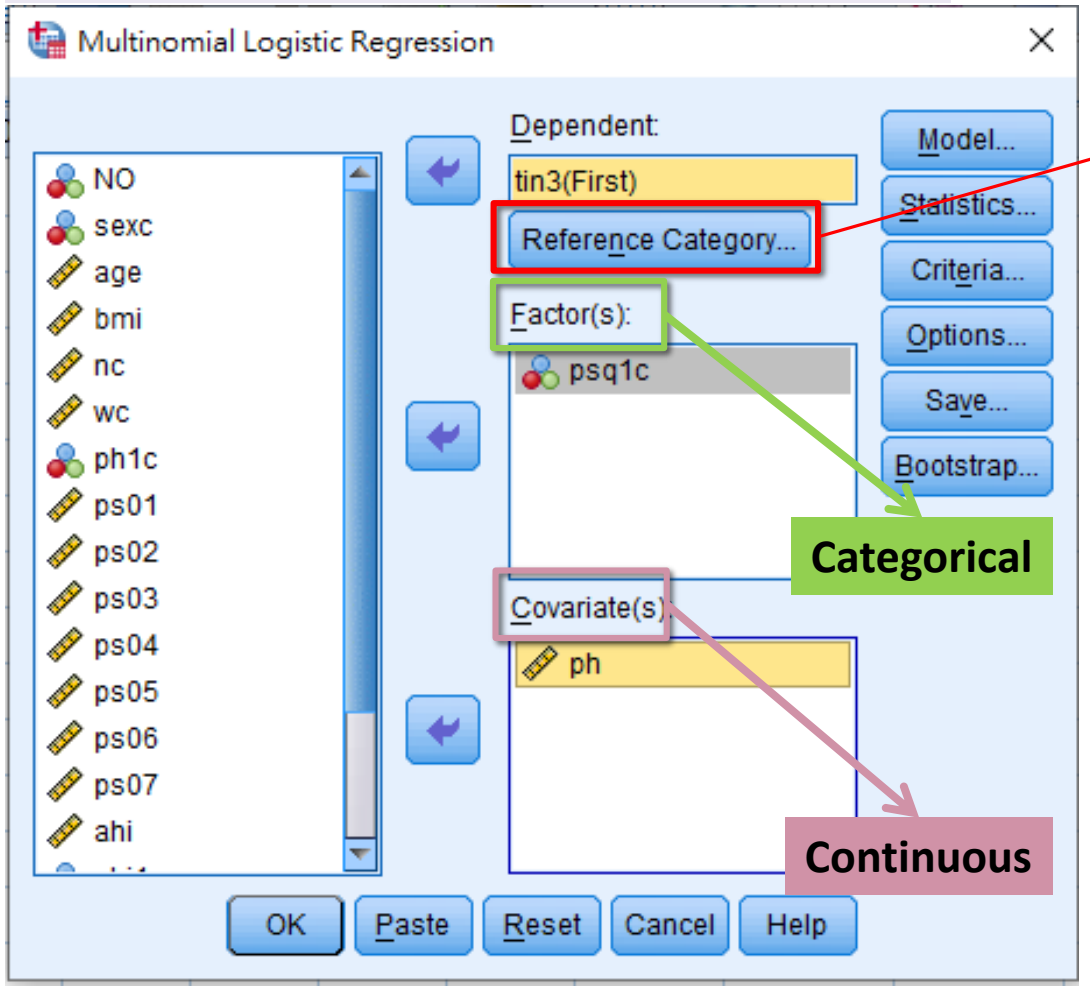
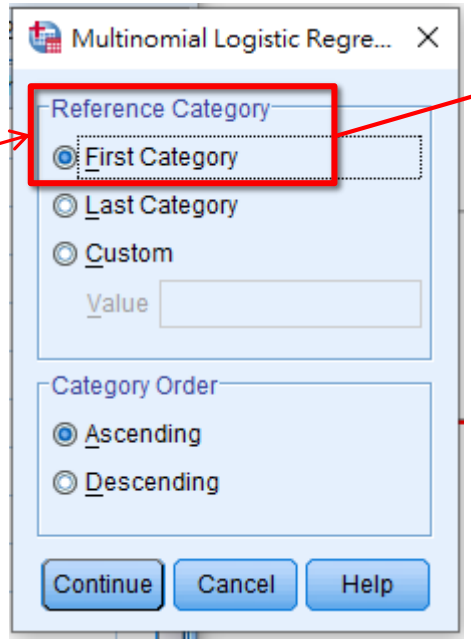
Multinomial Logistic regression

分析→迴歸→多項式Logistic





1 = Grade 1
2 = Grade 2
3 = Grade 3-5
目的：
Grade 2 vs Grade 1
Grade 3-5 vs Grade 1

Multinomial Logistic regression (SPSS output)

Parameter Estimates

OR

TIN-CM categorical[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Grade 2	Intercept	-.561	.678	.685	1	.408			
	ph	.001	.106	.000	1	.996	1.001	.823	1.216
	[psq1c=0]	1.200	.826	2.111	1	.146	3.318	.658	16.737
	[psq1c=1]	0[b]	.	.	0	.	.	.	.
Grade 3-5	Intercept	-2.888	1.206	5.735	1	.017			
	ph	.245	.103	5.689	1	.017	1.277	1.045	1.561
	[psq1c=0]	1.795	1.223	2.152	1	.142	6.018	.547	66.201
	[psq1c=1]	0[b]	.	.	0	.	.	.	.

a. The reference category is: Grade 1.

b. This parameter is set to zero because it is redundant.

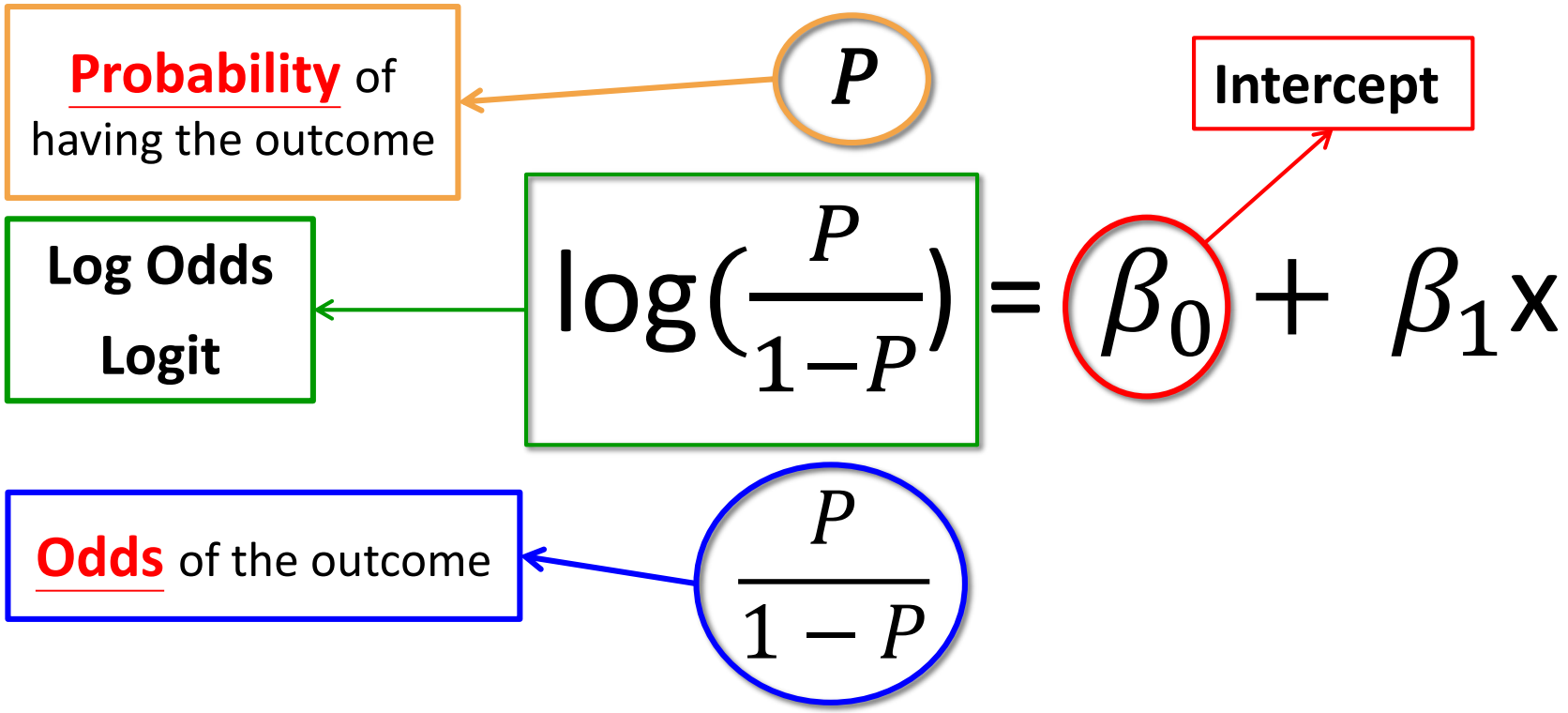
Obstructive sleep apnoea

PHQ-9 (total score)

Chang TG, Yao YT, Hsu CY, Yen TT. (2024). Exploring the interplay of depression, sleep quality, and hearing in tinnitus-related handicap: insights from polysomnography and pure-tone audiometry. *BMC Psychiatry*, *24* (1), 459. https://doi.org10.1186/s12888-024-05912-y.

From log odds to probability

logistic regression model with 1 predictor X



When X = 0,
the intercept β0 is the log of the odds of having the outcome

From log odds to probability

$$\ln\left(\frac{P}{1-P}\right) \rightarrow \frac{P}{1-P} = e^{\beta_0 + \beta_1 X}$$

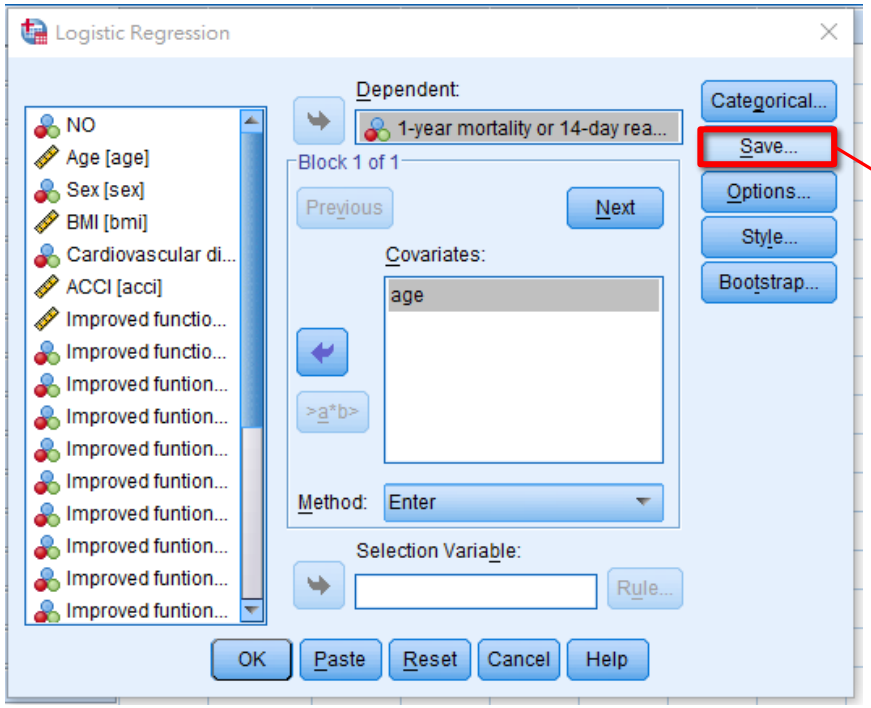
$$P = e^{\beta_0 + \beta_1 X} - P e^{\beta_0 + \beta_1 X}$$

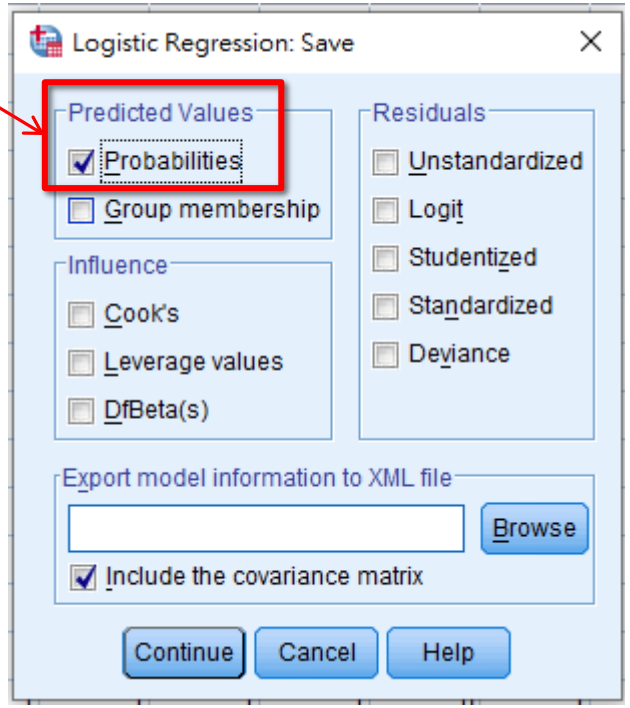
$$P\left(1 + e^{\beta_0 + \beta_1 X}\right) = e^{\beta_0 + \beta_1 X}$$

$$P = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}}$$

https://quantifyinghealth.com/interpret-logistic-regression-intercept/

From log odds to probability





SPSS probability

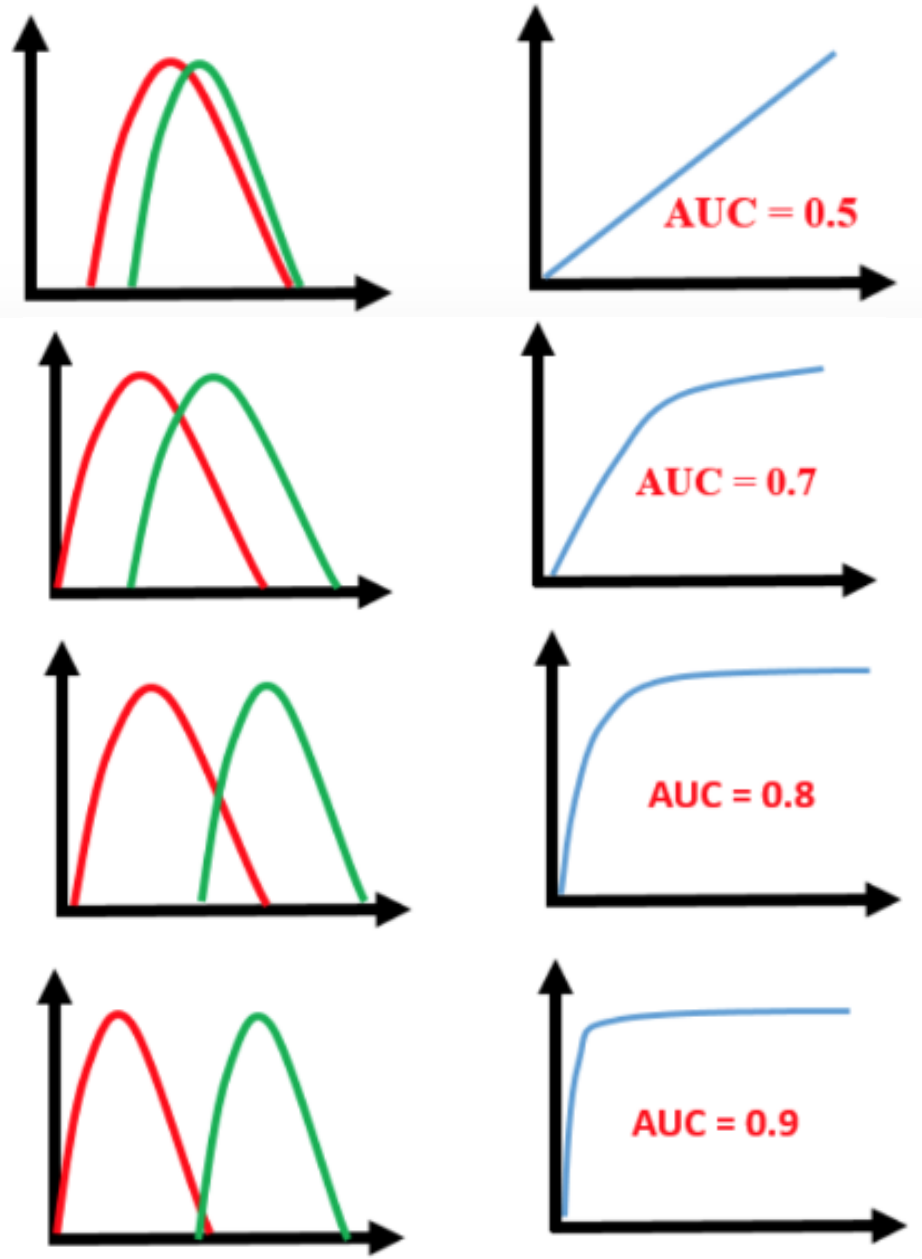
	NO	Y1	age	PRE_1
1	1	0	64	.05584
2	2	0	83	.12198
3	3	0	61	.04914
4	4	0	79	.10399
5	5	0	79	.10399
6	6	0	93	.17882
7	7	0	60	.04708
8	8	0	67	.06339
9	9	0	67	.06339
10	10	0	66	.06077
11	11	0	32	.01384
12	12	1	86	.13717
13	13	0	72	.07811

ROC Curve Analysis

- 使用時機
  - 當開發新的檢驗方法，無法決定臨界值 (Cut-off value)
  - 利用連續數值預測結果 (二元分類)
- 目的
  - 將連續數值決定臨界值
  - 用來比較不同工具的好壞

ROC Curve Analysis

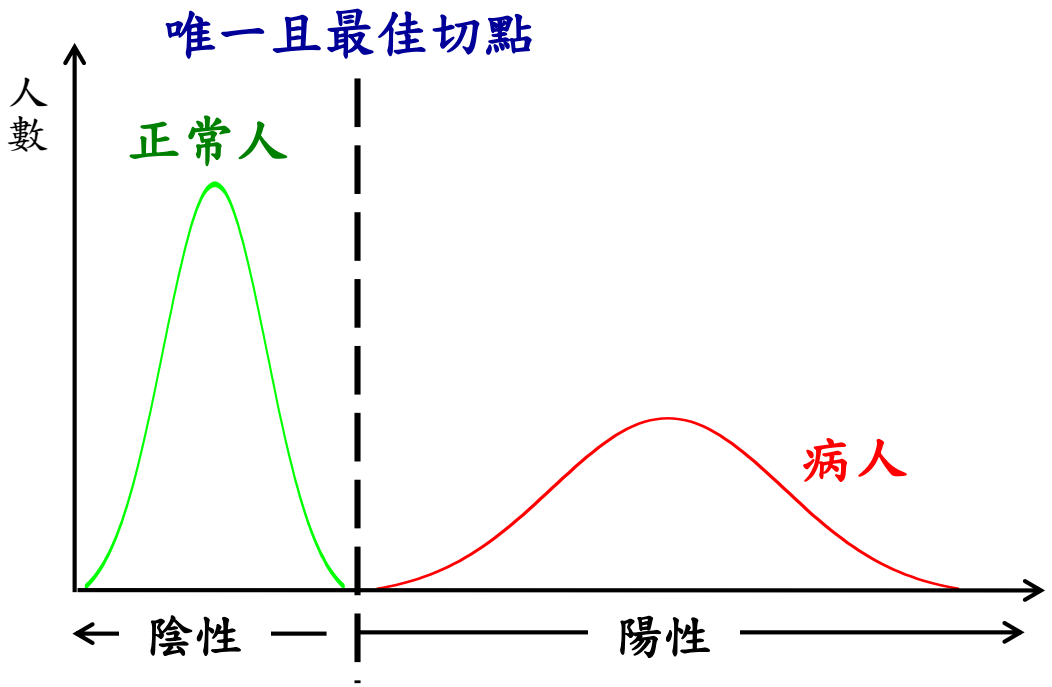
AUC	Discrimination
0.5	No discrimination
0.7-0.8	Acceptable discrimination
0.8-0.9	Excellent discrimination
0.9-1.0	Outstanding discrimination

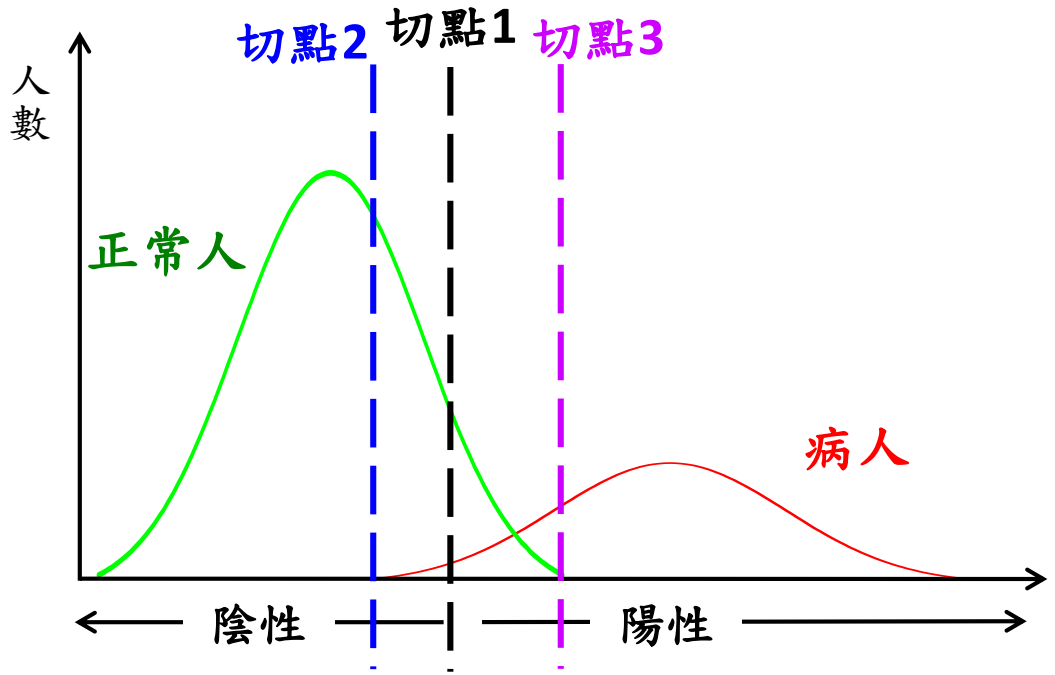


Ref: https://reurl.cc/288Xr9

ROC Curve Analysis

- Cut-point





ROC Curve Analysis

- Youden's index
  - 反映在有疾病和沒有疾病的陽性結果可能機率
  - 公式
    - Sensitivity + Specificity - 1
    - Sensitivity - False positive
  - Range 0-1
  - 不受盛行率影響
  - Maximum
    - Cut-point

診斷工具指標

Screen Test		Gold Standard Test: Disease	Gold Standard Test: Non-disease	
	Positive	a (True Positive)	b (False Positive)	a + b
	Negative	c (False Negative)	d (True Negative)	c + d
		a + c	b + d	a + b + c + d

- Sensitivity = $\frac{a}{(a+c)}$
- Specificity = $\frac{d}{(b+d)}$
- Positive predictive value, PPV = $\frac{a}{(a+b)}$
- Negative predictive value, NPV = $\frac{d}{(c+d)}$
- Accuracy = $\frac{(a+d)}{(a+b+c+d)}$
- False positive, FP = $\frac{b}{(a+b)}$
- False negative, FN = $\frac{c}{(c+d)}$

診斷工具指標

- Likelihood ratio positive, LR+ = $\frac{\text{Sensitivity}}{(1 - \text{Specificity})}$

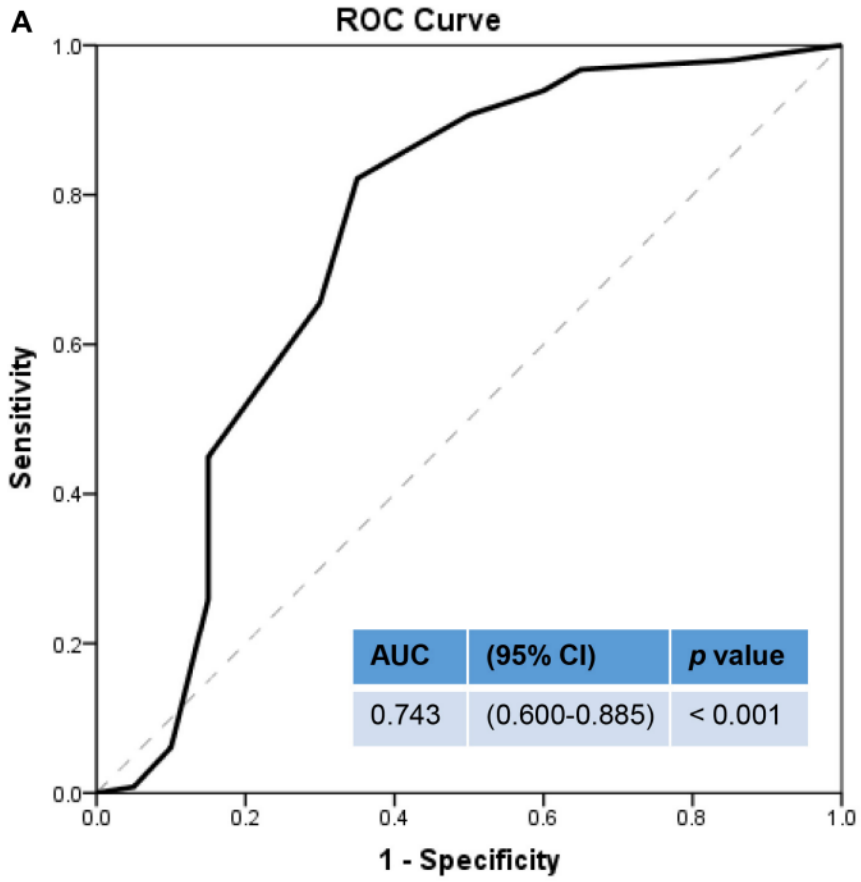
- Likelihood ratio negative, LR- = $\frac{(1 - \text{Sensitivity})}{\text{Specificity}}$

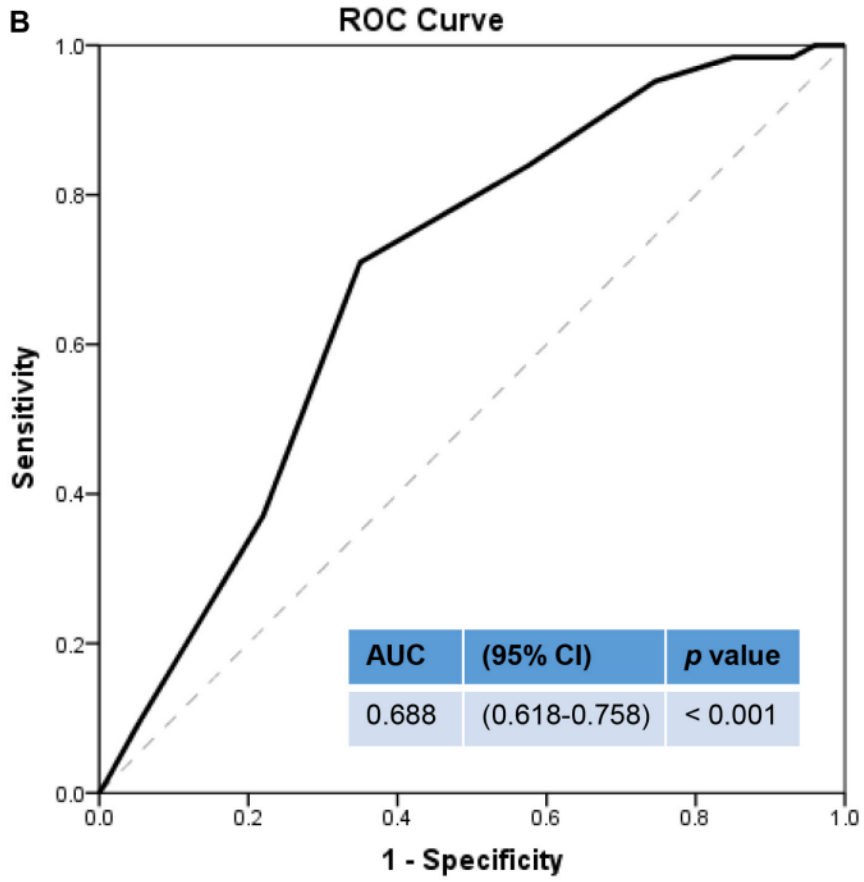
概似比的臨床意義	
LR	**Interpretation**
>10	Strong evidence to rule in disease
5-10	Moderate evidence to rule in disease
2-5	Weak evidence to rule in disease
0.5-2.0	No signification change in the likelihood of disease
0.2-0.5	Weak evidence to rule out disease
0.1-0.2	Moderate evidence to rule out disease
< 0.1	Strong evidence to rule out disease

Source: Sackett, Richardson, Rosenberg, Haynes. Evidence-Based Medicine: How to Practice and Teach EBM. Churchill Livingstone, London, 1997.

ROC Curve Analysis

Example





Improved functionality in PAC settings

	AUC	(95% CI)	*p* value	Cut-off point	Sensitivity	Specificity	Accuracy	PPV	NPV
Outcome 1	0.743	(0.600-0.885)	< 0.001**	≥5	82.19	65.00	80.90	96.67	22.81
Outcome 2	0.688	(0.618-0.758)	< 0.001**	≥7	70.97	65.00	66.41	38.60	87.84

Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

ROC Curve Analysis

SPSS dataset

	NO	Y1	age	sex
1	1	0	64	2
2	2	0	83	2
3	3	0	61	1
4	4	0	79	2
5	5	0	79	2
6	6	0	93	2
7	7	0	60	1
8	8	0	67	1
9	9	0	67	2
10	10	0	66	2
11	11	0	32	2
12	12	1	86	1
13	13	0	72	2

Data View | Variable View

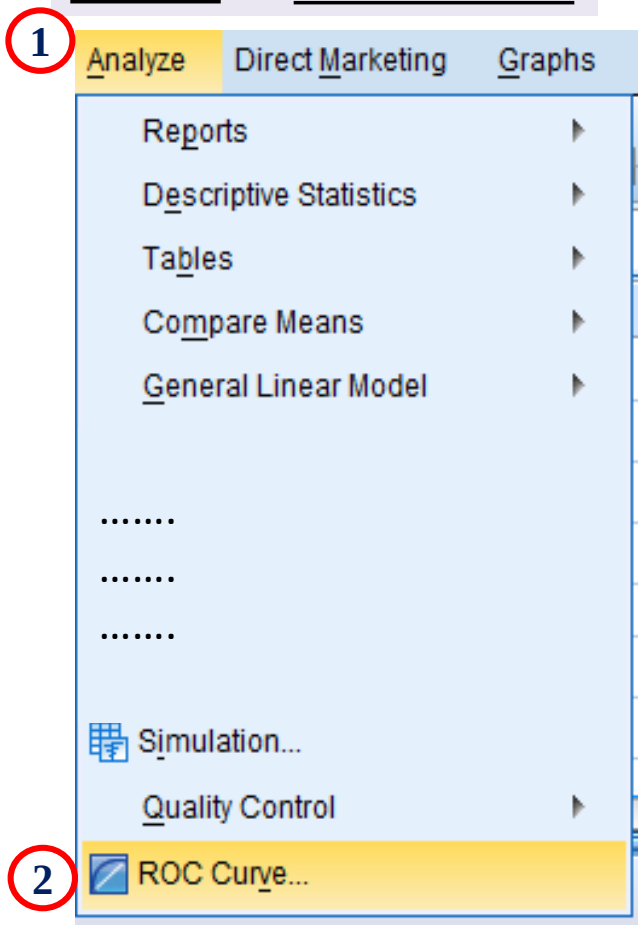
	Name	Type	Width	Decimals	Label	Values
1	NO	Numeric	8	0		None
2	Y1	Numeric	8	0	1-year mortality or 14-day readmission outcome	{0, No}...
3	age	Numeric	8	0	Age	None
4	sex	Numeric	8	0	Sex	{1, Male}...
5	bmi	Numeric	8	0	BMI	None
6	cvd	Numeric	8	0	Cardiovascular disease	{0, No}...
7	acci	Numeric	8	0	ACCI	None
8	ifn	Numeric	8	0	Improved functional numbers	None
9	ifn1	Numeric	8	0	Improved functional numbers (≥ 5 vs. < 5)	{0, No}...
10	P01	Numeric	8	0	Improved funtionality_MRS	{0, No}...
11	P02	Numeric	8	0	Improved funtionality_ADLs	{0, No}...
12	P03	Numeric	8	0	Improved funtionality_IADLs	{0, No}...
13	P04	Numeric	8	0	Improved funtionality_FOIS	{0, No}...

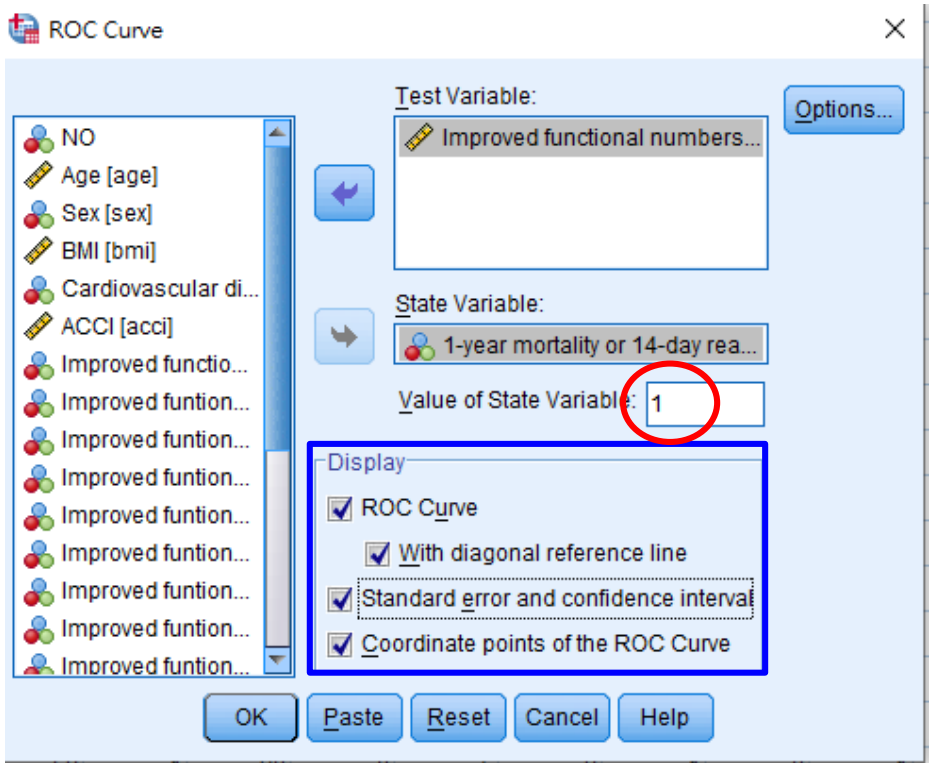
Data View | Variable View

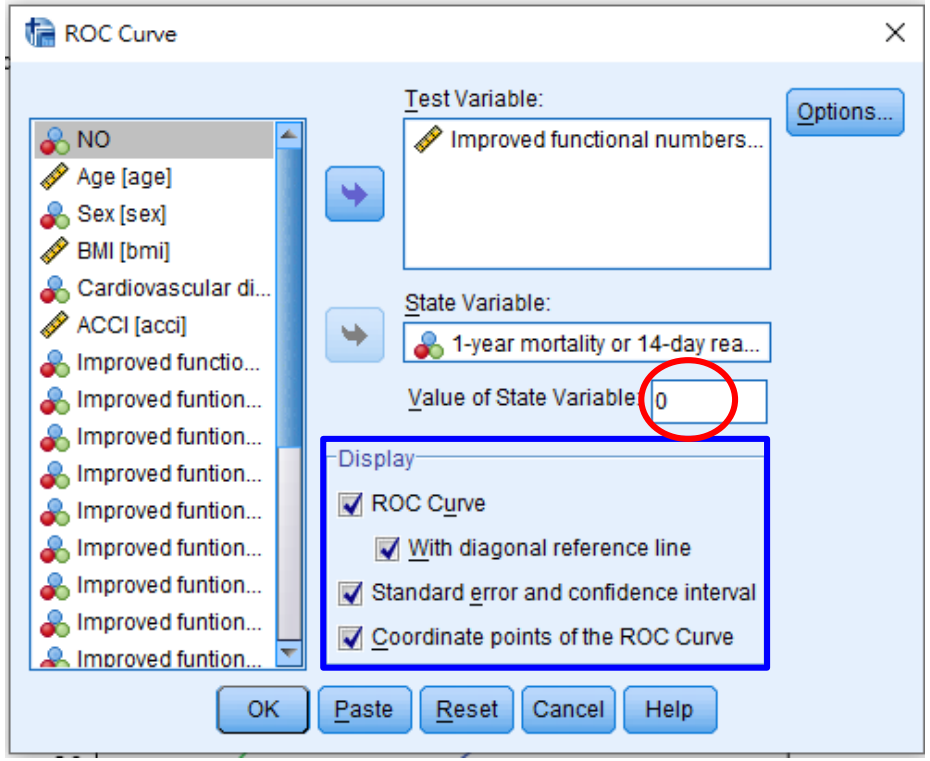
Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

ROC Curve Analysis

分析→ROC曲線





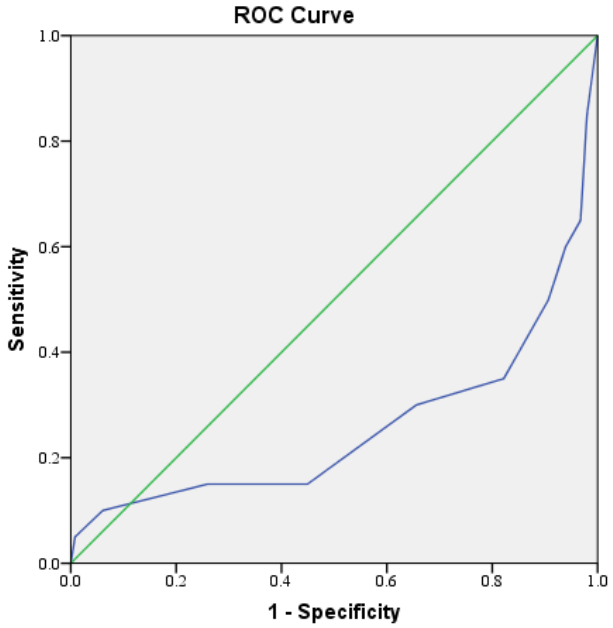


Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

ROC Curve Analysis (SPSS output)

State Variable: 1-year mortality or 14-day rea...

Value of State Variable: 1



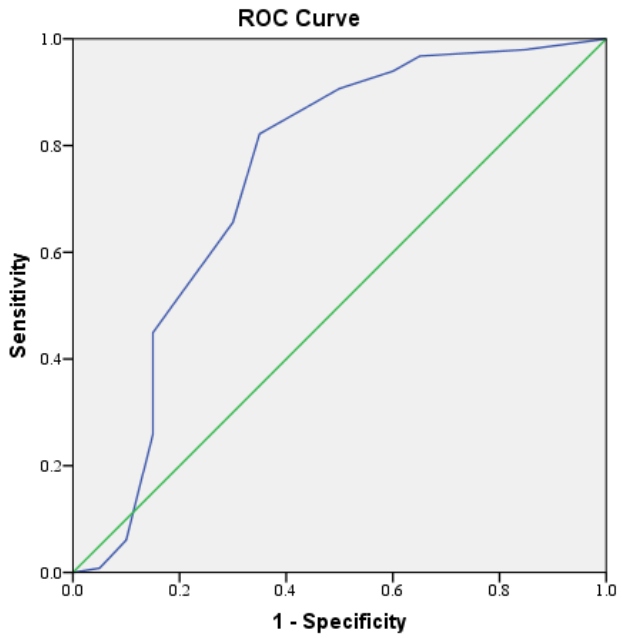
Area Under the Curve

Test Result Variable(s): Improved functional numbers

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.257	.073	.000	.115	.400

State Variable: 1-year mortality or 14-day rea...

Value of State Variable: 0



Area Under the Curve

Test Result Variable(s): Improved functional numbers

AUC

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.743	.073	.000	.600	.885

Coordinates of the Curve

Test Result Variable(s): Improved functional n

Positive if Greater Than or Equal To[a]	Sensitivity	1 - Specificity
-1.00	1.000	1.000
.50	.980	.850
1.50	.968	.650
2.50	.939	.600
3.50	.907	.500
4.50	.822	.350
5.50	.656	.300
6.50	.449	.150
7.50	.259	.150
8.50	.061	.100
9.50	.008	.050
11.00	.000	.000

Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

ROC Curve Analysis (SPSS output)

Area Under the Curve

Test Result Variable(s): Improved functional numbers

AUC

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.743	.073	.000	.600	.885

Coordinates of the Curve

Test Result Variable(s): Improved functional n

Positive if Greater Than or Equal To[a]	Sensitivity	1 - Specificity
-1.00	1.000	1.000
.50	.980	.850
1.50	.968	.650
2.50	.939	.600
3.50	.907	.500
4.50	.822	.350
5.50	.656	.300
6.50	.449	.150
7.50	.259	.150
8.50	.061	.100
9.50	.008	.050
11.00	.000	.000

貼至 Excel

Youden's index = Sensitivity + Specificity - 1

Coordinates of the Curve

Test Result Variable(s):

新增兩個欄位

	Sensitivity	1 - Specificity	spe	Youden's
5	.822	.350	0.650	0.472
4	.907	.500	0.500	0.407
6	.656	.300	0.700	0.356
3	.939	.600	0.400	0.339
2	.968	.650	0.350	0.318
7	.449	.150	0.850	0.299
1	.980	.850	0.150	0.130
8	.259	.150	0.850	0.109
-1	1.000	1.000	0.000	0.000
11	.000	.000	1.000	0.000
9	.061	.100	0.900	-0.039
10	.008	0.050	0.950	-0.042

大

小

=1-N12

N	O
1 - Specificity	spe
.350	=1-N12

=M12+O12-1

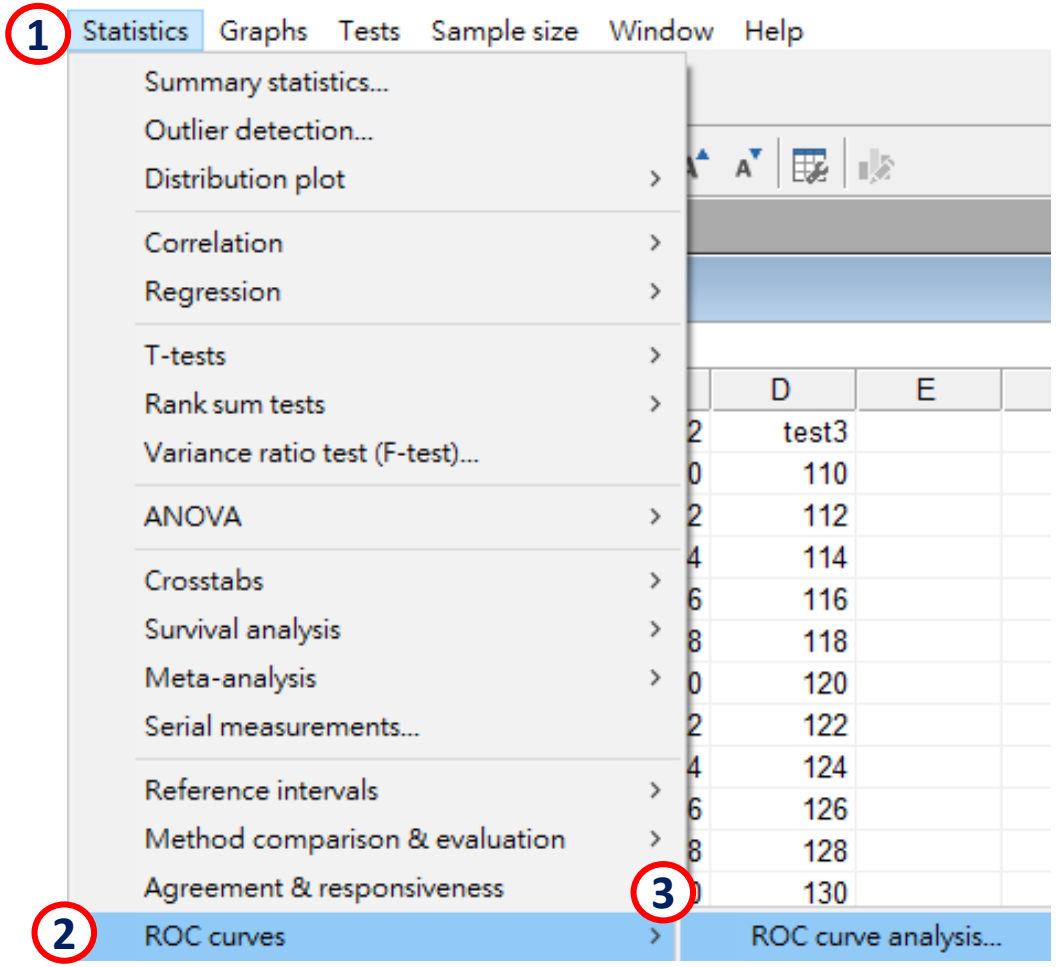
M	N	O	P
Sensitivity	1 - Specificity	spe	Youden's
.822	.350	0.650	=M12+O12-1

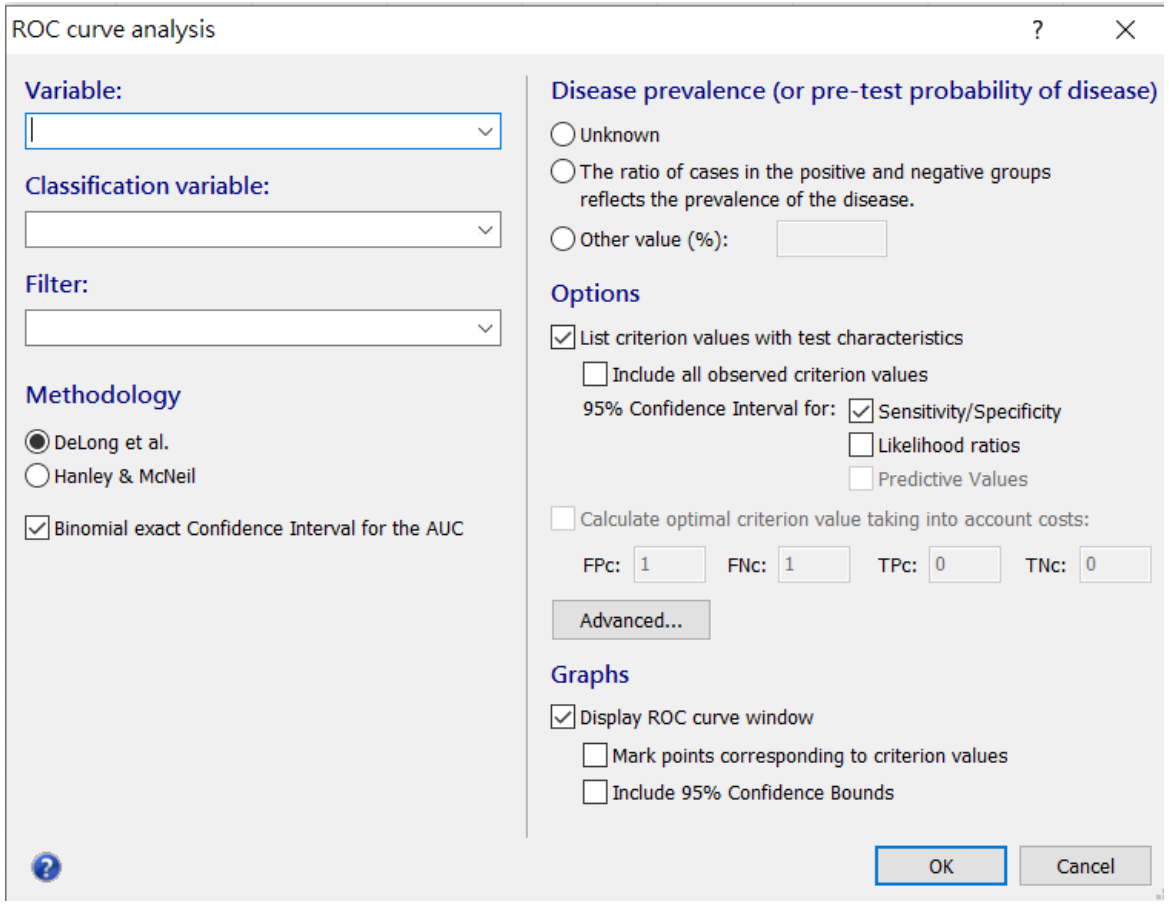
Weng SC, Hsu CY, Shen CC, Huang JA, Chen PL, Lin SY. (2022). Combined Functional Assessment for Predicting Clinical Outcomes in Stroke Patients After Post-acute Care: A Retrospective Multi-Center Cohort in Central Taiwan. *Front Aging Neurosci*, *14*, 834273.

ROC Curve Analysis (Medcalc)

Statistics → ROC curves → ROC Curve Analysis

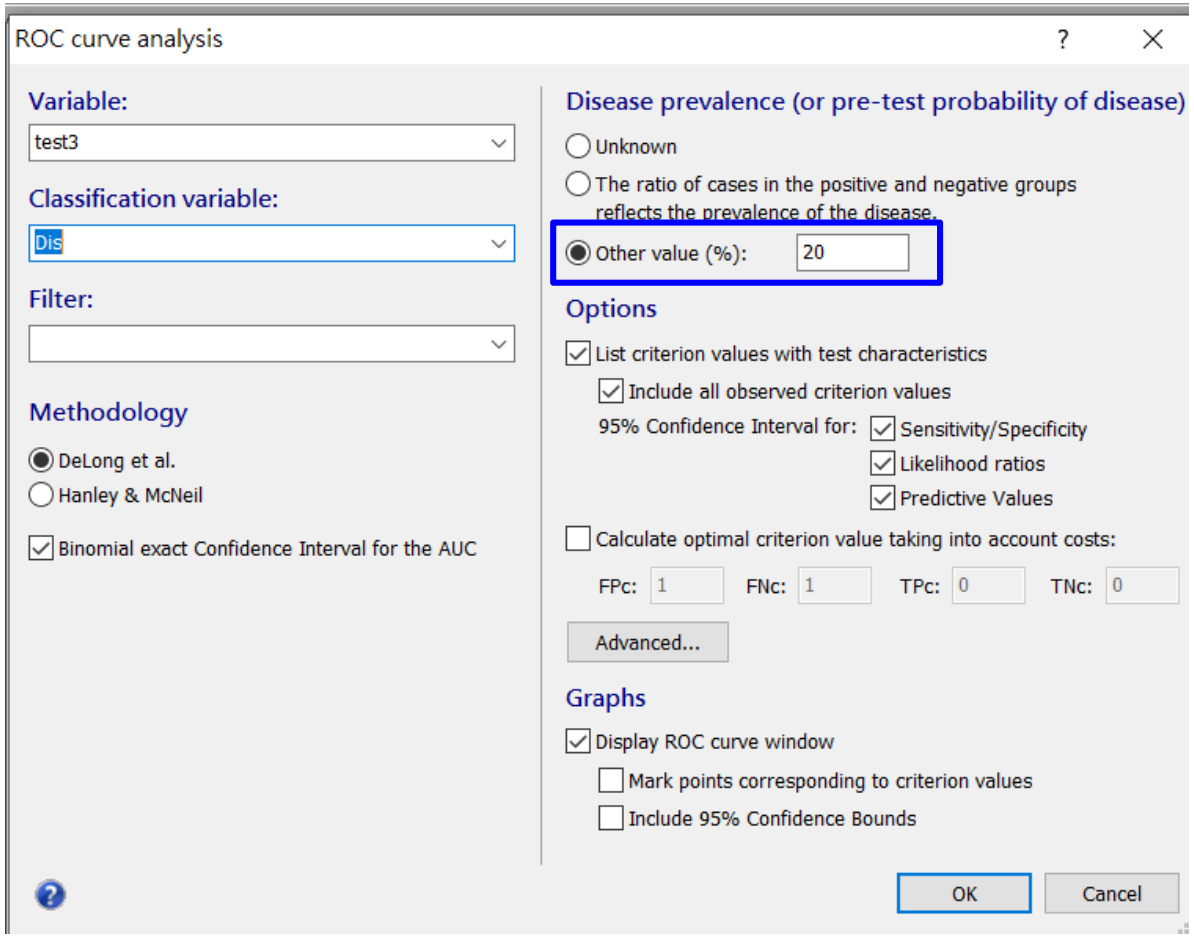
https://www.medcalc.org/download/

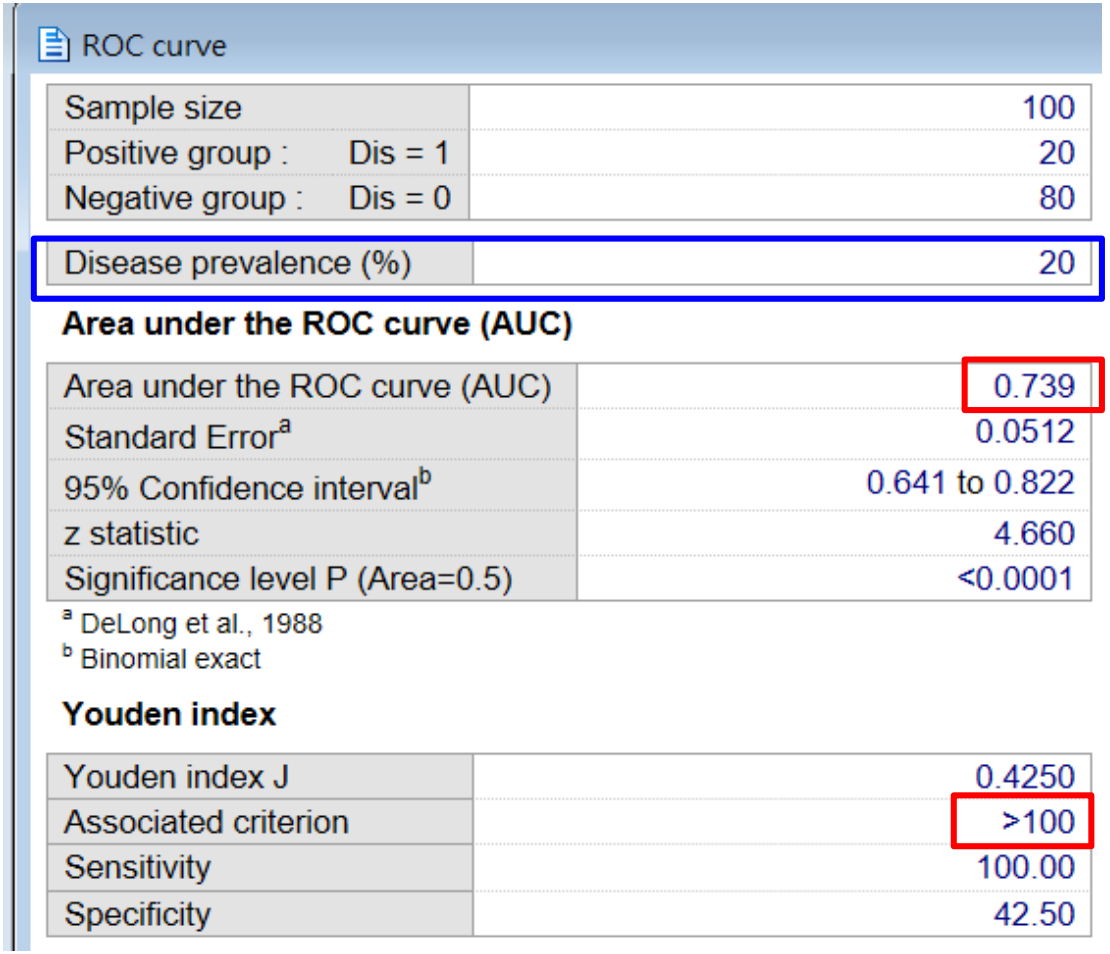




ROC Curve Analysis (Medcalc)

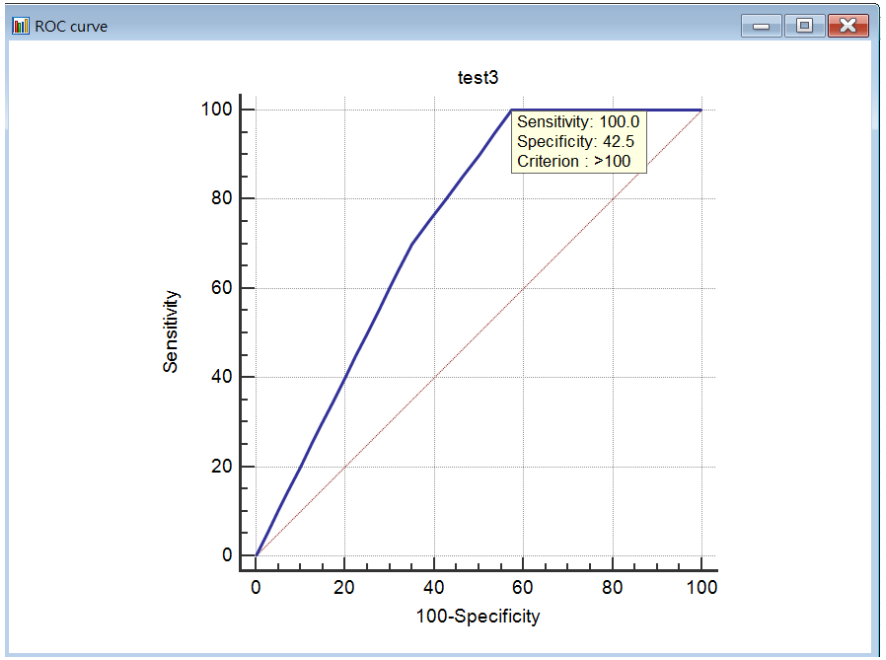
Statistics → ROC curves → ROC Curve Analysis





ROC Curve Analysis (Medcalc)

Statistics → ROC curves → ROC Curve Analysis

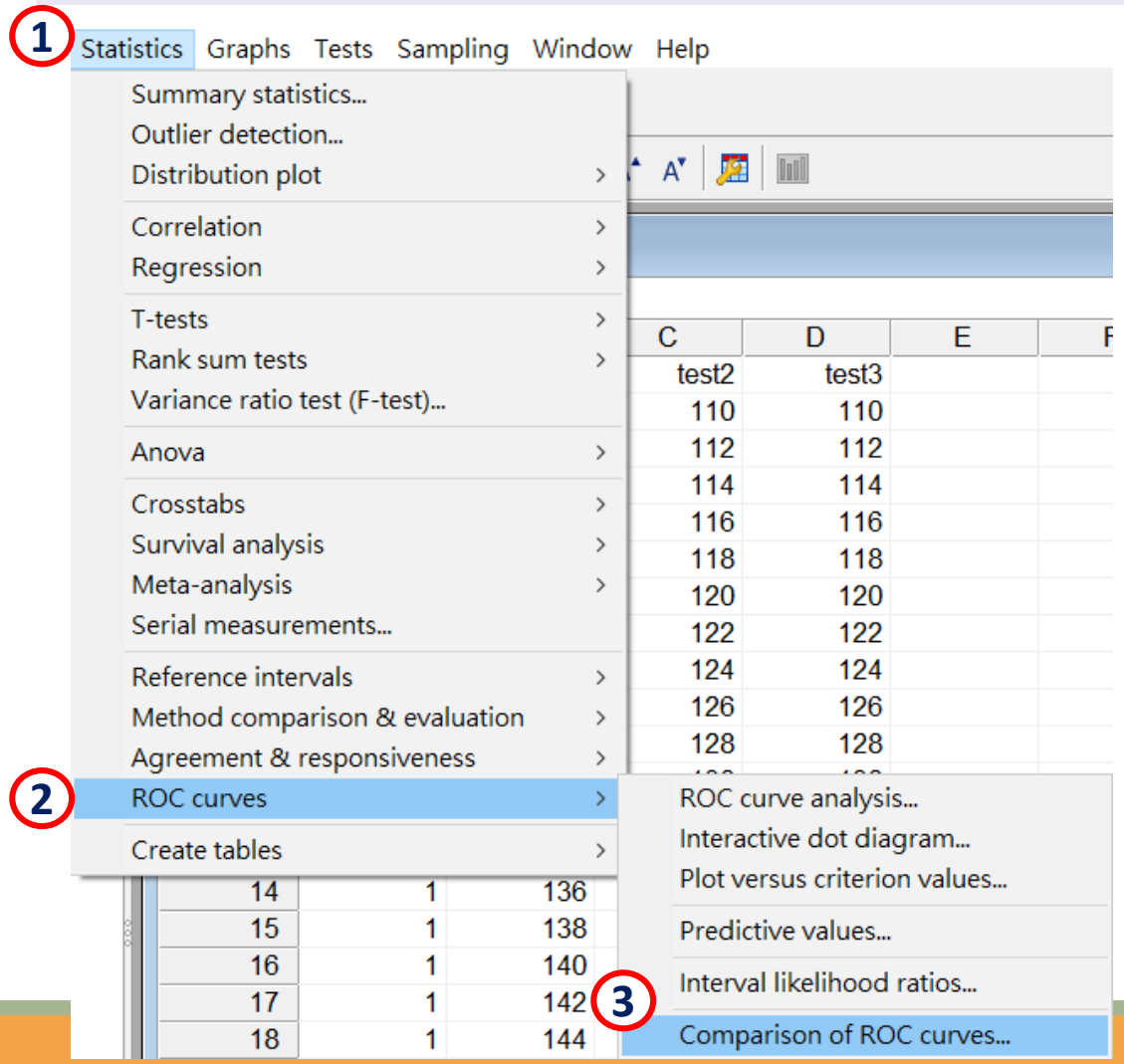


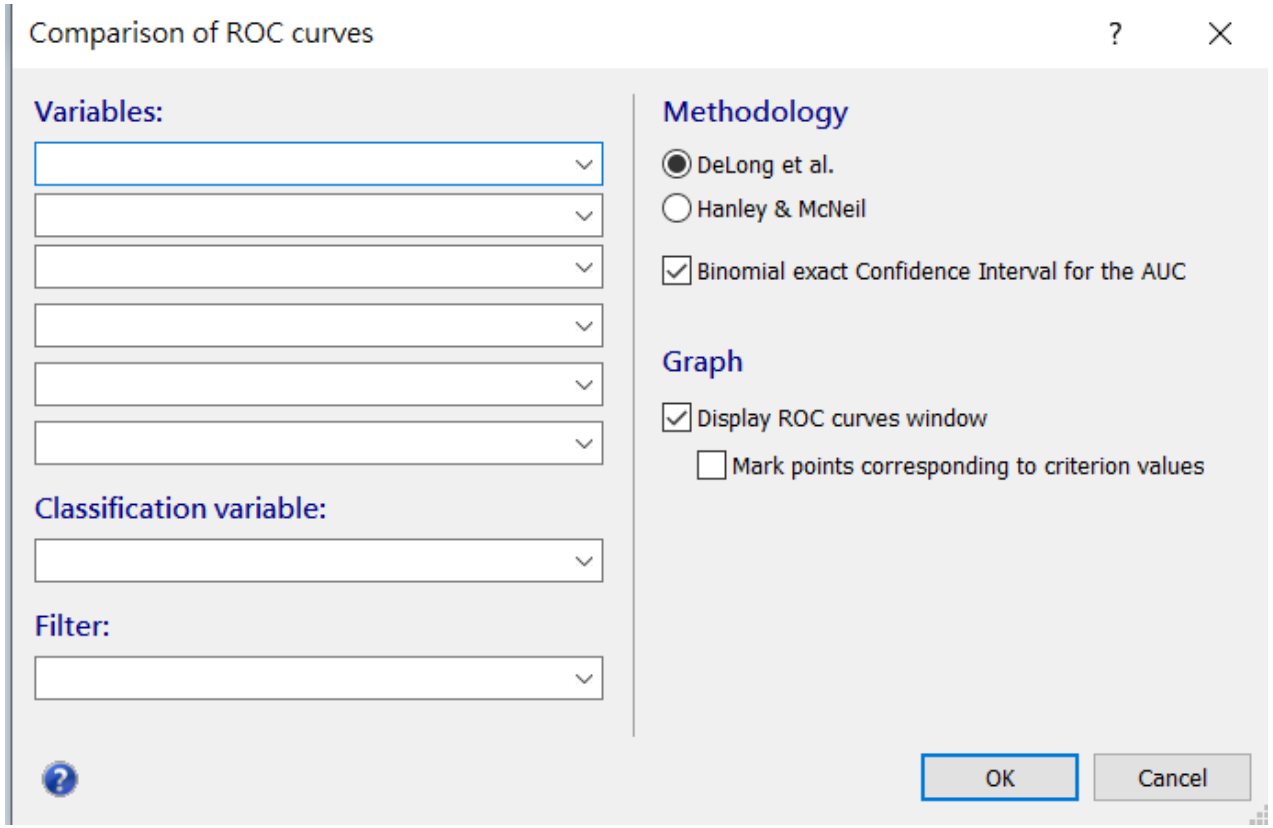
Criterion values and coordinates of the ROC curve [Hide]

Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	95% CI	-LR	95% CI	+PV	95% CI	-PV	95% CI
≥80	100.00	83.2 - 100.0	0.00	0.0 - 4.5	1.00	1.0 - 1.0			20.0	12.7 - 29.2		
>80	100.00	83.2 - 100.0	2.50	0.3 - 8.7	1.03	1.0 - 1.1	0.00		20.4	12.9 - 29.7	100.0	15.8 - 100.0
>82	100.00	83.2 - 100.0	5.00	1.4 - 12.3	1.05	1.0 - 1.1	0.00		20.8	13.2 - 30.3	100.0	39.8 - 100.0
>84	100.00	83.2 - 100.0	7.50	2.8 - 15.6	1.08	1.0 - 1.2	0.00		21.3	13.5 - 30.9	100.0	54.1 - 100.0
>86	100.00	83.2 - 100.0	10.00	4.4 - 18.8	1.11	1.0 - 1.2	0.00		21.7	13.8 - 31.6	100.0	63.1 - 100.0
>88	100.00	83.2 - 100.0	12.50	6.2 - 21.8	1.14	1.1 - 1.2	0.00		22.2	14.1 - 32.2	100.0	69.2 - 100.0
>90	100.00	83.2 - 100.0	17.50	9.9 - 27.6	1.21	1.1 - 1.3	0.00		23.3	14.8 - 33.6	100.0	76.8 - 100.0
>92	100.00	83.2 - 100.0	22.50	13.9 - 33.2	1.29	1.1 - 1.5	0.00		24.4	15.6 - 35.1	100.0	81.5 - 100.0
>94	100.00	83.2 - 100.0	27.50	18.1 - 38.6	1.38	1.2 - 1.6	0.00		25.6	16.4 - 36.8	100.0	84.6 - 100.0
>96	100.00	83.2 - 100.0	32.50	22.4 - 43.9	1.48	1.3 - 1.7	0.00		27.0	17.4 - 38.6	100.0	86.8 - 100.0
>98	100.00	83.2 - 100.0	37.50	26.9 - 49.0	1.60	1.4 - 1.9	0.00		28.6	18.4 - 40.6	100.0	88.4 - 100.0
>100	100.00	83.2 - 100.0	42.50	31.5 - 54.1	1.74	1.4 - 2.1	0.00		30.3	19.6 - 42.9	100.0	89.7 - 100.0
>110	95.00	75.1 - 99.9	46.25	35.0 - 57.8	1.77	1.4 - 2.2	0.11	0.02 - 0.7	30.6	19.6 - 43.7	97.4	86.2 - 99.9
>112	90.00	68.3 - 98.8	50.00	38.6 - 61.4	1.80	1.4 - 2.3	0.20	0.05 - 0.8	31.0	19.5 - 44.5	95.2	83.8 - 99.4
>114	85.00	62.1 - 96.8	53.75	42.2 - 65.0	1.84	1.4 - 2.5	0.28	0.10 - 0.8	31.5	19.5 - 45.6	93.5	82.1 - 98.6
>116	80.00	56.3 - 94.3	57.50	45.9 - 68.5	1.88	1.3 - 2.6	0.35	0.1 - 0.9	32.0	19.5 - 46.7	92.0	80.8 - 97.8
>118	75.00	50.9 - 91.3	61.25	49.7 - 71.9	1.94	1.3 - 2.8	0.41	0.2 - 0.9	32.6	19.5 - 48.0	90.7	79.7 - 96.9
>120	70.00	45.7 - 88.1	65.00	53.5 - 75.3	2.00	1.3 - 3.0	0.46	0.2 - 0.9	33.3	19.6 - 49.5	89.7	78.8 - 96.1
>122	65.00	40.8 - 84.6	67.50	56.1 - 77.6	2.00	1.3 - 3.1	0.52	0.3 - 1.0	33.3	19.1 - 50.2	88.5	77.8 - 95.3
>124	60.00	36.1 - 80.9	70.00	58.7 - 79.7	2.00	1.2 - 3.3	0.57	0.3 - 1.0	33.3	18.6 - 51.0	87.5	76.8 - 94.4
>126	55.00	31.5 - 76.9	72.50	61.4 - 81.9	2.00	1.2 - 3.4	0.62	0.4 - 1.0	33.3	18.0 - 51.8	86.6	76.0 - 93.7
>128	50.00	27.2 - 72.8	75.00	64.1 - 84.0	2.00	1.1 - 3.6	0.67	0.4 - 1.1	33.3	17.3 - 52.8	85.7	75.3 - 92.9
>130	45.00	23.1 - 68.5	77.50	66.8 - 86.1	2.00	1.1 - 3.8	0.71	0.5 - 1.1	33.3	16.5 - 54.0	84.9	74.6 - 92.2
>132	40.00	19.1 - 63.9	80.00	69.6 - 88.1	2.00	1.0 - 4.0	0.75	0.5 - 1.1	33.3	15.6 - 55.3	84.2	74.0 - 91.6
>134	35.00	15.4 - 59.2	82.50	72.4 - 90.1	2.00	0.9 - 4.3	0.79	0.6 - 1.1	33.3	14.6 - 57.0	83.5	73.5 - 90.9
>136	30.00	11.9 - 54.3	85.00	75.3 - 92.0	2.00	0.9 - 4.7	0.82	0.6 - 1.1	33.3	13.3 - 59.0	82.9	73.0 - 90.3
>138	25.00	8.7 - 49.1	87.50	78.2 - 93.8	2.00	0.8 - 5.2	0.86	0.7 - 1.1	33.3	11.8 - 61.6	82.4	72.6 - 89.8
>140	20.00	5.7 - 43.7	90.00	81.2 - 95.6	2.00	0.7 - 6.0	0.89	0.7 - 1.1	33.3	9.9 - 65.1	81.8	72.2 - 89.2
>142	15.00	3.2 - 37.9	92.50	84.4 - 97.2	2.00	0.5 - 7.3	0.92	0.8 - 1.1	33.3	7.5 - 70.1	81.3	71.8 - 88.7
>144	10.00	1.2 - 31.7	95.00	87.7 - 98.6	2.00	0.4 - 10.2	0.95	0.8 - 1.1	33.3	4.3 - 77.7	80.9	71.4 - 88.2
>146	5.00	0.1 - 24.9	97.50	91.3 - 99.7	2.00	0.2 - 21.0	0.97	0.9 - 1.1	33.3	0.8 - 90.6	80.4	71.1 - 87.8
>148	0.00	0.0 - 16.8	100.00	95.5 - 100.0			1.00	1.0 - 1.0			80.0	70.8 - 87.3

ROC Curve Analysis (Medcalc)

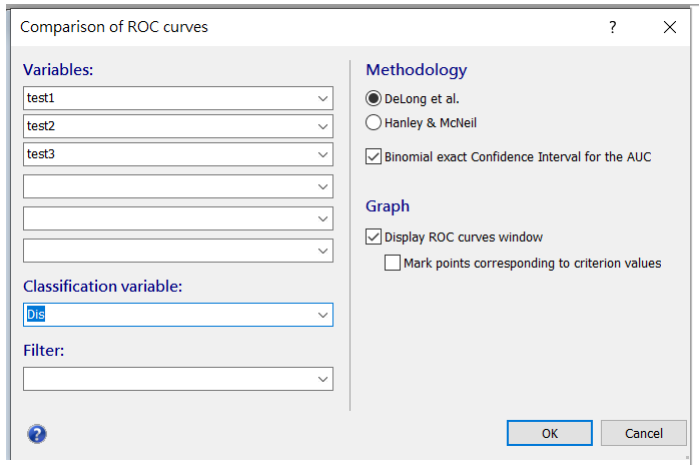
Statistics → ROC curves → Comparison of ROC Curves

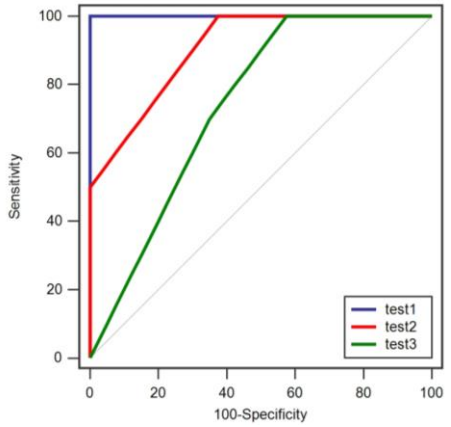




ROC Curve Analysis (Medcalc)

Statistics → ROC curves → ROC Curve Analysis





Variable 1	test1
Variable 2	test2
Variable 3	test3
Classification variable	Dis

Sample size		100
Positive group :	Dis = 1	20
Negative group :	Dis = 0	80

	AUC	SE [a]	95% CI [b]
test1	1.000	0.000	0.964 to 1.000
test2	0.906	0.0324	0.831 to 0.955
test3	0.739	0.0512	0.641 to 0.822

[a] DeLong et al., 1988
[b] Binomial exact

Pairwise comparison of ROC curves

test1 ~ test2	
Difference between areas	0.0937
Standard Error[c]	0.0324
95% Confidence Interval	0.0302 to 0.157
z statistic	2.892
Significance level	P = 0.0038
test1 ~ test3	
Difference between areas	0.261
Standard Error[c]	0.0512
95% Confidence Interval	0.161 to 0.362
z statistic	5.099
Significance level	P < 0.0001
test2 ~ test3	
Difference between areas	0.168
Standard Error[c]	0.0349
95% Confidence Interval	0.0991 to 0.236
z statistic	4.797
Significance level	P < 0.0001

[c] DeLong et al., 1988

生統小組：統計方法教育訓練

Thank you

課程問卷

11/26問卷

For your attention!!