迴歸分析

醫學研究部 基礎醫學科 生統小組

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日期：114年4月22日

Regression

	Linear Regression		Logistic Regression	
依變項(Y)	連續資料		二元類別資料 (0 / 1)	
自變項(X)	**1個**自變項	**多個**自變項	**1個**自變項	**多個**自變項
	簡單迴歸分析	複迴歸分析	單變數邏輯斯迴歸分析	多變項邏輯斯迴歸分析
	可為連續或類別資料		可為連續或類別資料	
	類別資料需設定虛擬變數 (Dummy variable)		類別資料需設定參考組	

Dummy variable

性別		D1
1	**Female**	**0**
2	Male	**1**

婚姻		D1	D2
1	**已婚**	**0**	**0**
2	單身	**1**	0
3	離婚	0	**1**

教育程度		D1	D2	D3
1	**國中以下**	**0**	**0**	**0**
2	高中	**1**	0	0
3	大專大學	0	**1**	0
4	研究所	0	0	**1**

分數分組		D1	D2	D3	D4
1	**1-20**	**0**	**0**	**0**	**0**
2	21-40	**1**	0	0	0
3	41-60	0	**1**	0	0
4	61-80	0	0	**1**	0
5	91-100	0	0	0	**1**

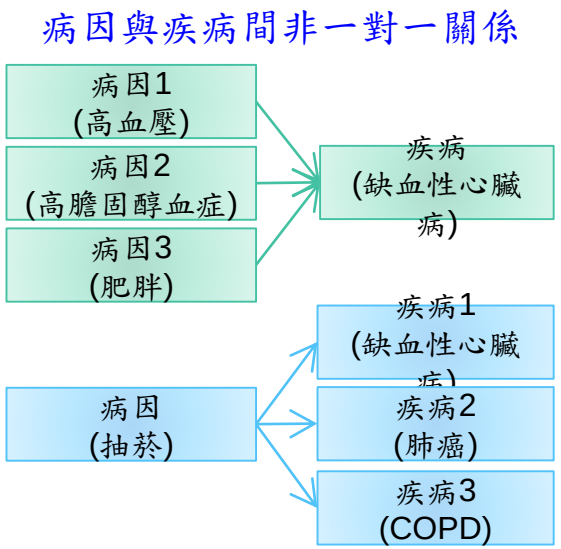
虛擬變項**個數(n)**，
依**分組組別數(k)**決定

n=k-1

Association does not imply causation

因果關係條件

- 正確的**時序性**
  - 必要條件 (因必須發生在果之前)
- 重複研究的相關一致性
- 相關強度
  - 劑量效應關係
- **相關**特異性
  - 一對一關係
- **相關**的合理解釋
  - 生物贊同性

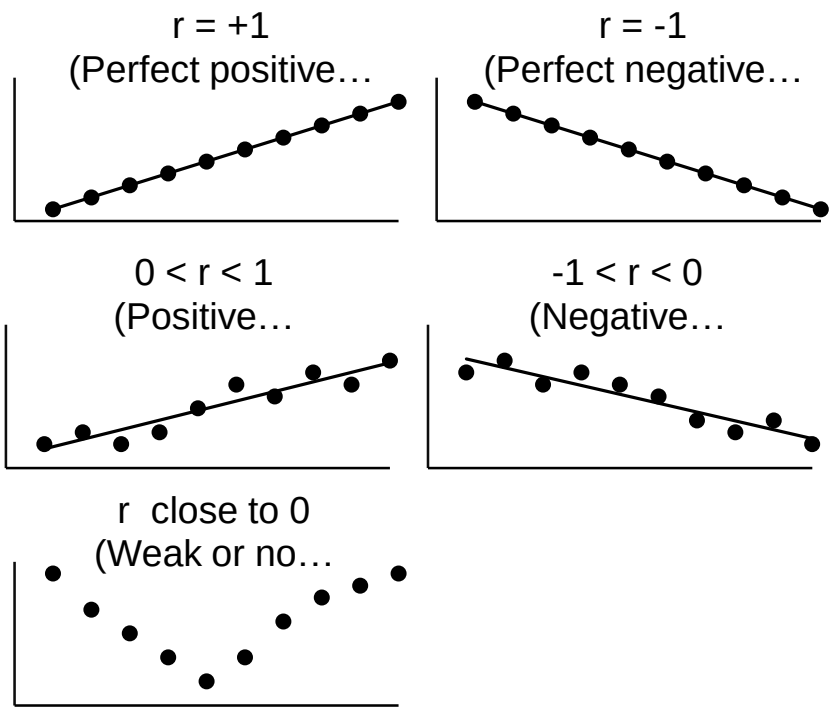


希爾於1964年在美國公共衛生局諮詢委員會，提出五項因果關係判斷準則 (希爾準則, Hill's criteria for causation)

Correlation

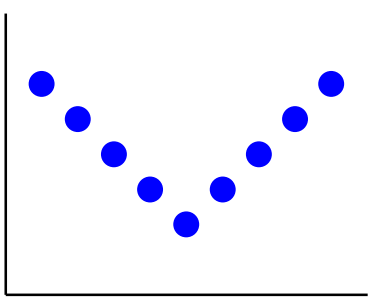
- 兩個連續變項之間的關係
- 相關強度
  - Range (-1 to 1)

相關係數	相關	
1	完全	
0.70 - 0.99	高度	相關
0.50 - 0.69	中度	
0.25 - 0.49	低度	
0.00 - 0.24	無	

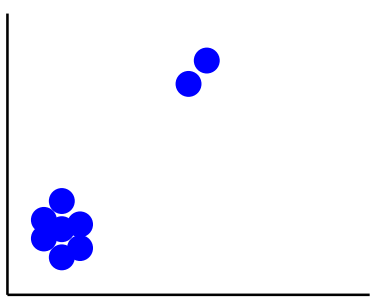


Correlation

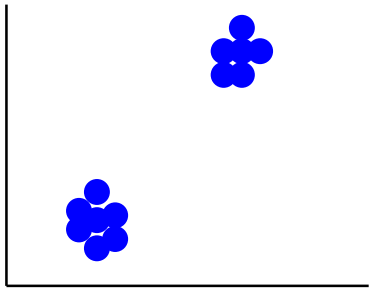
- 不適合計算相關係數(r)的資料



(a) 非線性關係, $r = 0$



(b) 有極端值存在

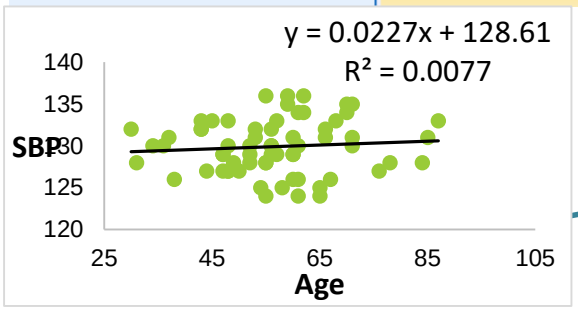


(c)分群資料

Correlation

	Pearson correlation	Spearman rank Correlation
Distribution	• Normal distribution	• Skewed distribution
Types of Data	• Continuous	• Ordinal • Continuous

Pearson correlation



$R^2 = 0.0077$
$r = 0.088$

相關

		age	SBP
age	皮爾森 (Pearson) 相關	1	.088
	顯著性（雙尾）		.487
	N	65	65
SBP	皮爾森 (Pearson) 相關	.088	1
	顯著性（雙尾）	.487	
	N	65	65

	Age	
	r	*p* value
SBP	0.088	0.487

範例：Reg.xls-reg1

Spearman rank correlation

相關

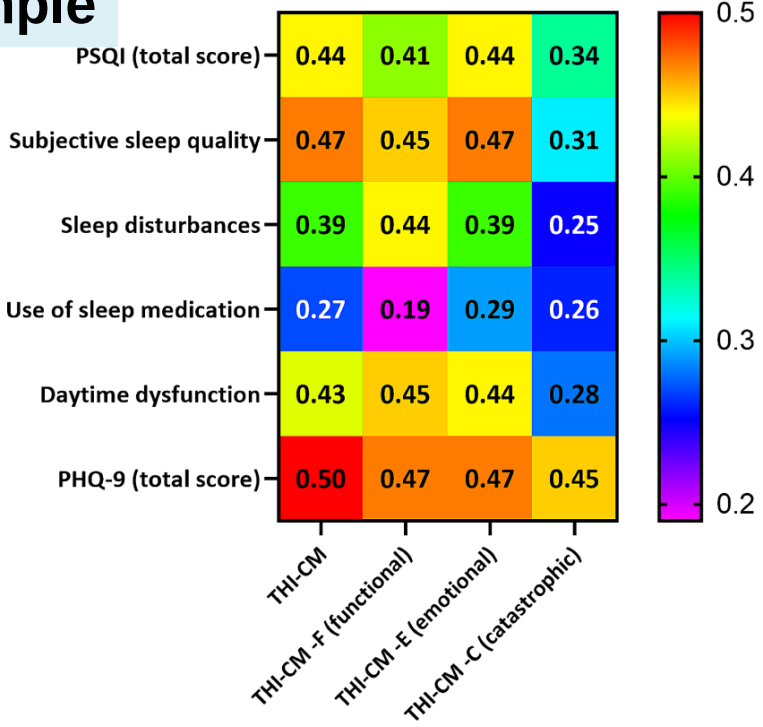
			age	SBP
Spearman 的 rho	age	相關係數	1.000	.105
		顯著性（雙尾）	.	.405
		N	65	65
	SBP	相關係數	.105	1.000
		顯著性（雙尾）	.405	.
		N	65	65

	Age	
	r_s	*p* value
SBP	0.105	0.405

範例：Reg.xls-reg1

Spearman rank correlation

Example



Correlations between the THI-CM scores and different variables (n=65)

	THI-CM		THI-CM -F (functional)		THI-CM -E (emotional)		THI-CM -C (catastrophic)	
	r_s	*p* value	r_s	*p* value	r_s	*p* value	r_s	*p* value
PSQI (total score)	0.44	<0.001**	0.41	0.001**	0.44	<0.001**	0.34	0.005**
Subjective sleep quality	0.47	<0.001**	0.45	<0.001**	0.47	<0.001**	0.31	0.011*
Sleep disturbances	0.39	0.001**	0.44	<0.001**	0.39	0.001**	0.25	0.049*
Use of sleep medication	0.27	0.032*	0.19	0.130	0.29	0.017*	0.26	0.039*
Daytime dysfunction	0.43	<0.001**	0.45	<0.001**	0.44	<0.001**	0.28	0.023*
PHQ-9 (total score)	0.50	<0.001**	0.47	<0.001**	0.47	<0.001**	0.45	<0.001**

Spearman's rank correlation was used to obtain the data. *p<0.05, **p<0.01.

Fig. 1 the correlations between the Chinese-Mandarin version of the Tinnitus Handicap Inventory score (THI-CM), Pittsburgh Sleep Quality Index score (PSQI) and Patient Health Questionnaire-9 score (PHQ-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.

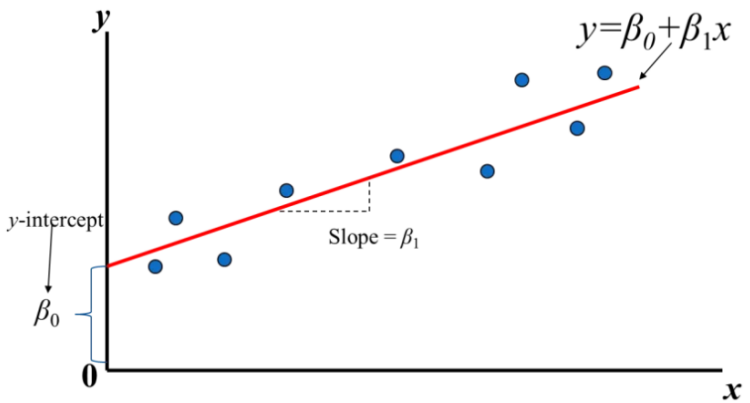
Linear regression

- 簡單迴歸 $\hat{Y} = \beta_0 + \beta_1 X_1 + \varepsilon$
- 複迴歸 $\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n + \varepsilon$
- 前提假設 (誤差項)
  - 常態(Normality)
    - Kolmogorov-Smirnov test / Shapiro-Wilk t
  - 獨立(Independency)
    - Durbin-Watson test
  - 變異數同質(Constant Variance)
    - Residual Plot

β_0,常數項
β_1,迴歸係數
ε 誤差項

簡單線性回歸: $y=\beta 0+\beta 1x$

$\beta 0$：截距(Intercept)，$\beta 1$：斜率(Slope)為 x變動一個單位y變動的量，如下圖:



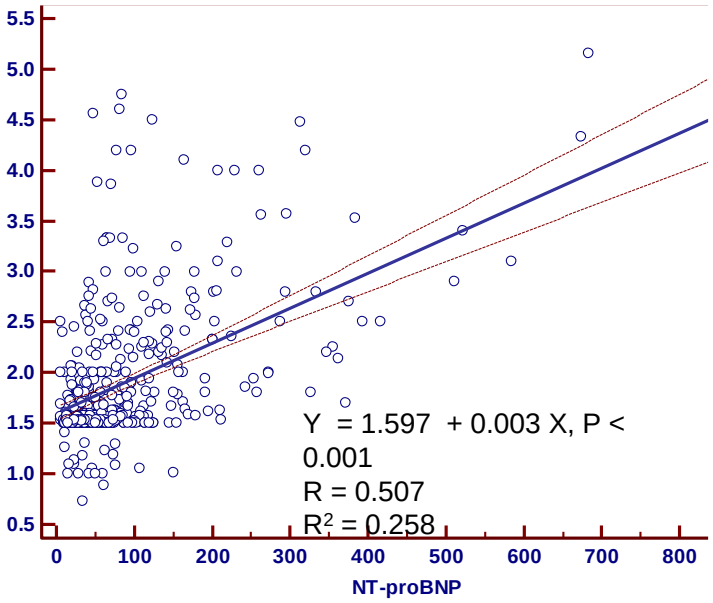
回歸分析就只是在找β0和β1

Linear regression

Linear regression
X = NT-proBNP
Y = Qp/Qs

相關係數 (R):
0.3以下為低相關，
0.3~0.7為中等相關，
0.7以上為高度相關

R^2是模型的解釋度



Regression Equation

y = 1.5970 + 0.003460 x					
Parameter	Coefficient	Std. Error	95% CI	t	P
Intercept	1.5970	0.03530	1.5277 to 1.6664	45.2365	<0.0001
Slope	0.003460	0.0002737	0.002923 to 0.003998	12.6455	<0.0001

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.507[a]	.258	.256	.574567	.258	159.909	1	461	.000

a. Predictors: (Constant), NT-proBNP

Linear regression

- 簡單迴歸分析
  - 範例一：年齡與收縮壓的相關性 (連續 vs 連續)
  - 範例二：性別與收縮壓的相關性 (類別 vs 連續)
  - 範例三：年齡分層與收縮壓的相關性 (類別 vs 連續)
    - 年齡分層共三組，需設定**虛擬變數**
- 複迴歸分析
  - 範例四：年齡、性別及BMI值與收縮壓的相關性

Linear regression

- 範例一：年齡與收縮壓的相關性 (連續 vs 連續)
  - 自變項(X)與依變項(Y)皆為連續資料
    - **可互換，但分析結果模式不同**

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例一：年齡與收縮壓之相關性

	B	(95%CI)	*p* value
Age	0.023	(-0.042 – 0.088)	0.487

Linear regression. *p<0.05, **p<0.01

範例一(A)：收縮壓與年齡之相關性

	B	95%CI	*p* value
SBP	0.339	(-0.630– 1.308)	0.487

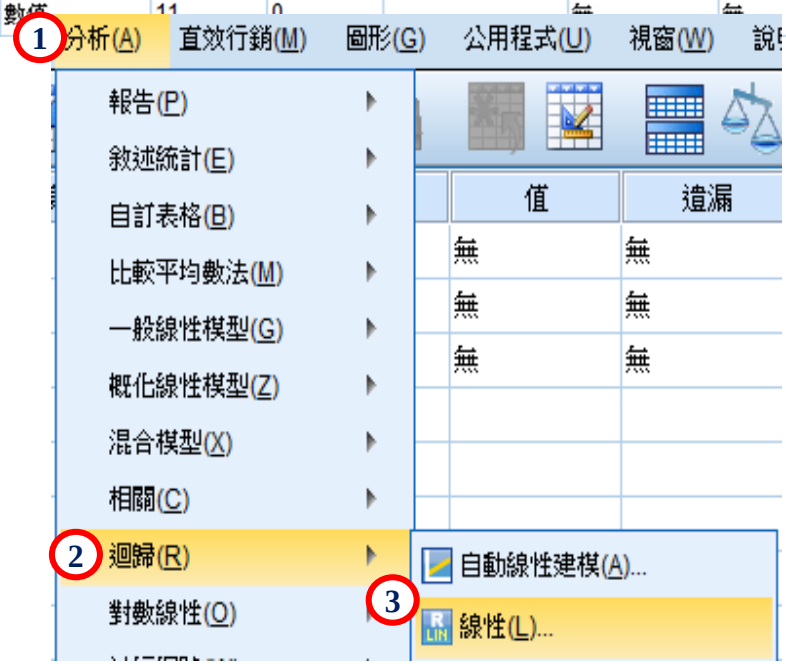
Linear regression. *p<0.05, **p<0.01

範例：Reg.xls-reg1

Linear regression

SPSS步驟 (範例一)

	名稱	類型	寬度	小數	標籤	值	遺漏	欄	對齊	測量
1	ID	字串	2	0		無	無	2	靠左	名義
2	age	數值	11	0		無	無	11	靠右	比例
3	SBP	數值	11	0		無	無	11	靠右	比例



ID	age	SBP
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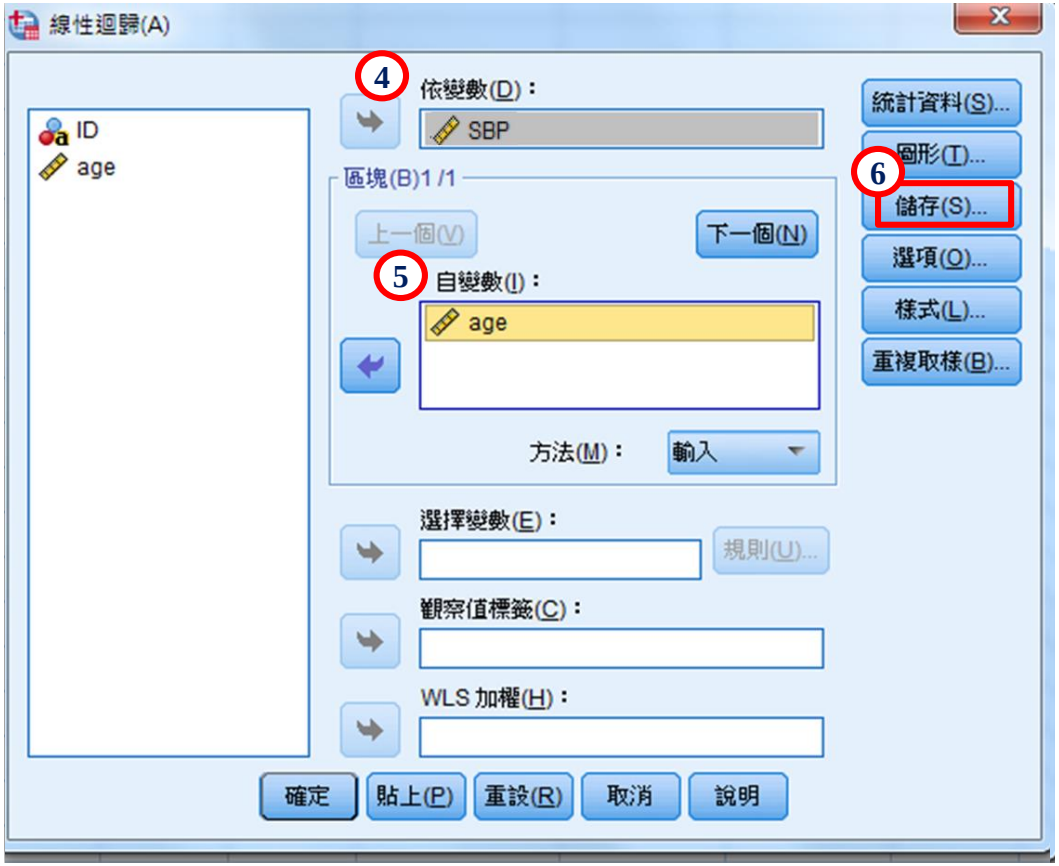
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS步驟 (範例一)



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05	47	129
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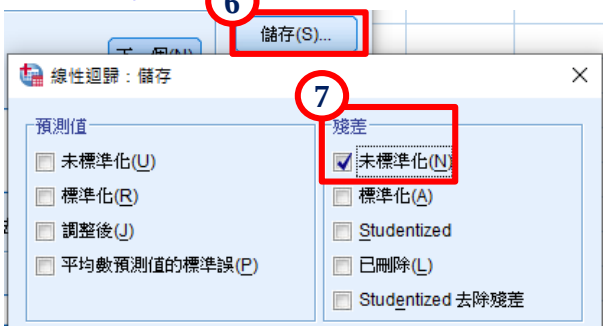
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS步驟(範例一)



Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	.055	65	.200*	.981	65	.430

假設1.
殘差符合常態

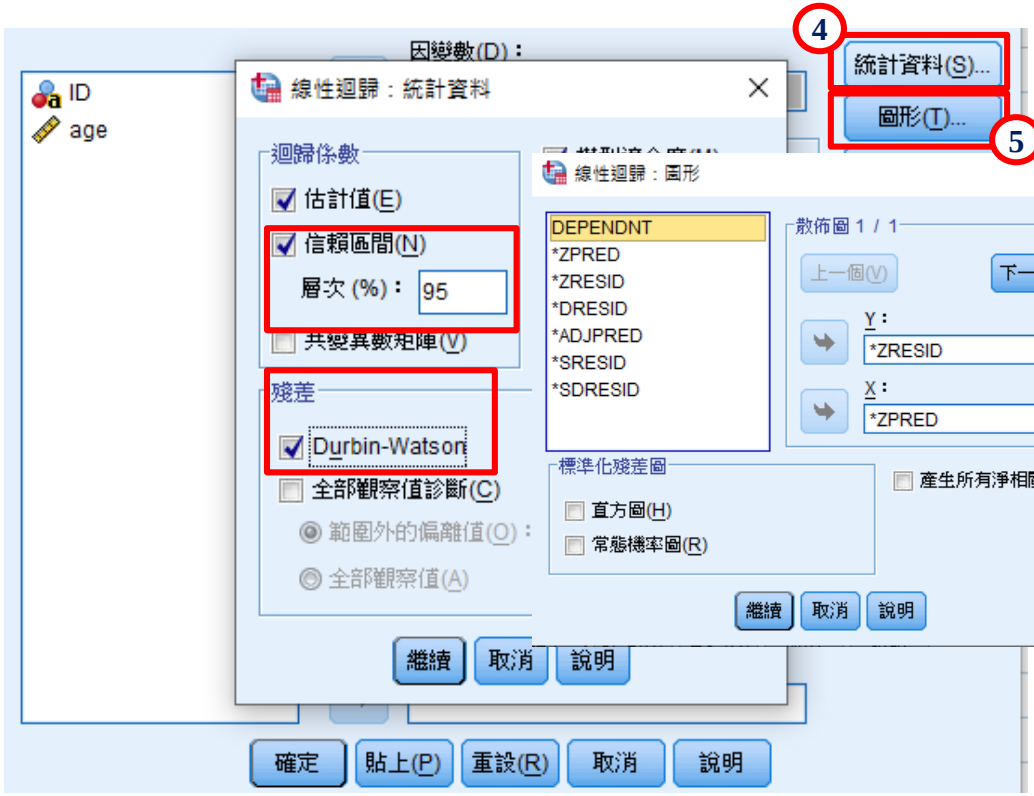
	ID	age	SBP	RES_1
1	01	70	134	3.80131
2	02	76	127	-3.33510
3	03	84	128	-2.51697
4	04	85	131	.46030
5	05	47	129	-.67581
6	06	65	124	-6.08502
7	07	34	130	.61973
8	08	48	130	.30146
		78	128	-2.38057
		45	133	3.36966
		60	129	-.97135
		57	133	3.09685
		57	129	-.90315
14	14	60	129	-.97135
15	15	43	132	2.41513

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS步驟 (範例一)



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03	84	128
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05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS結果 (範例一)

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	age[b]	.	Enter

a. Dependent Variable: SBP

b. All requested variables entered.

強迫(Enter)：挑選的變項全部放入
向前(Forward) ：對於Y的貢獻(解釋力)由大到小挑選
向後(Backward)：對於Y的貢獻(解釋力)由小到大刪除
逐步(Stepwise) ：結合向前和向後的方式

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.088[a]	.008	-.008	3.200	2.333

a. Predictors: (Constant), age

b. Dependent Variable: SBP

假設2. 殘差獨立性
Durbin-Watson test (殘差項獨立性)
數值範圍0-4
越接近2 ， 殘差項間愈獨立

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.017	1	5.017	.490	.487[b]
	Residual	645.230	63	10.242		
	Total	650.246	64			

a. Dependent Variable: SBP

b. Predictors: (Constant), age

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS結果 (範例一)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	128.607	1.878		68.463	.000	124.853	132.361
	age	.023	.032	.088	.700	.487	-.042	.088

a. Dependent Variable: SBP

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例一：年齡與收縮壓之相關性

	B	(95%CI)	*p* value
constant	128.607		
Age	0.023	(-0.042 – 0.088)	0.487

Linear regression. *p<0.05, **p<0.01.

SBP = 128.607 + 0.023 * Age

範例：Reg.xls-reg1

Linear regression

自變項、依變項互換，但分析結果模式不同

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例：Reg.xls-reg1

Linear regression

SPSS結果 (範例一)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	12.444	63.001		.198	.844	-113.453	138.341
	SBP	.339	.485	.088	.700	.487	-.630	1.308

a. Dependent Variable: age

ID	age	SBP
01	70	134
02	76	127
03	84	128
04	85	131
05	47	129
…	…	…
…	…	…
61	52	130
62	55	124
63	71	131
64	56	130
65	70	135

範例一(A)：收縮壓與年齡之相關性

	B	(95%CI)	*p* value
SBP	0.339	(-0.630– 1.308)	0.487

Linear regression. **p*<0.05, ***p*<0.01.

範例：Reg.xls-reg1

Linear regression

年齡每增加1歲、
收縮壓增加
0.023mmHg

收縮壓每增加1mmHg、
年齡增加0.339歲

範例一：年齡與收縮壓之相關性

	B	(95%CI)	*p* value
Age	0.023	(-0.042 – 0.088)	0.487

Linear regression. *p<0.05, **p<0.01.

範例一(A)：收縮壓與年齡之相關性

	B	(95%CI)	*p* value
SBP	0.339	(-0.630– 1.308)	0.487

Linear regression. *p<0.05, **p<0.01.

範例：Reg.xls-reg1

Simple linear regression

- 範例二：性別與收縮壓的相關性(類別 vs 連續)

	名稱	類型	寬度	小數	標籤	值	遺漏	欄	對齊	測量
1	ID	字串	2	0		無	無	2	靠左	名義
2	sex	數值	11	0		Female}...	無	11	靠右	名義
3	SBP	數值	11	0		無	無	11	靠右	比例

ID	sex	SBP
01	0	134
02	1	127
03	1	128
04	1	131
05	1	129
...	...	...
...	...	...
61	0	130
62	0	124
63	0	131
64	0	130
65	0	135

二元類別變項
(0 & 1)

範例：Reg.xls-reg2

Linear regression

SPSS結果 (範例二)

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	sex[b]	.	Enter

a. Dependent Variable: SBP

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.285[a]	.081	.067	3.079	2.325

a. Predictors: (Constant), sex

b. Dependent Variable: SBP

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.894	1	52.894	5.578	.021[b]
	Residual	597.352	63	9.482		
	Total	650.246	64			

a. Dependent Variable: SBP

b. Predictors: (Constant), sex

ID	sex	SBP
01	0	134
02	1	127
03	1	128
04	1	131
05	1	129
…	…	…
…	…	…
61	0	130
62	0	124
63	0	131
64	0	130
65	0	135

範例：Reg.xls-reg2

Linear regression

SPSS結果 (範例二)

類別資料與連續資料解釋方式不同
1.sex設定值，sex=0(女性)、sex=1(男性)
2.男性相較於女性，收縮壓低1.81mmHg

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	130.867	.562		232.779	.000	129.743	131.990
	sex	-1.810	.766	-.285	-2.362	.021	-3.341	-.279

a. Dependent Variable: SBP

範例二：性別與收縮壓之相關性

	B	(95%CI)	*p* value
Male vs Female	-1.81	(-3.34 – -0.28)	0.021*

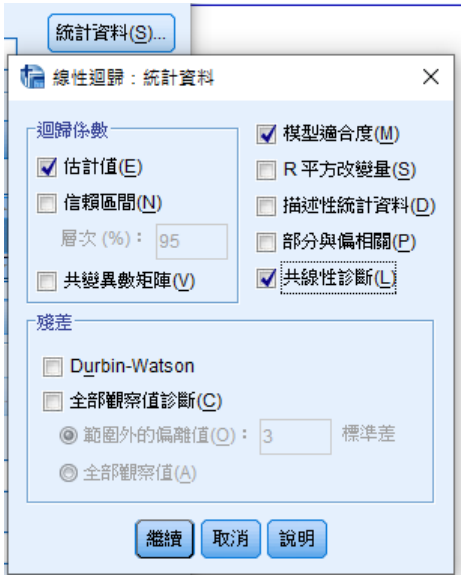
Linear regression. *p<0.05, **p<0.01

ID	sex	SBP
01	0	134
02	1	127
03	1	128
04	1	131
05	1	129
…	…	…
…	…	…
61	0	130
62	0	124
63	0	131
64	0	130
65	0	135

範例：Reg.xls-reg2

Linear regression

- 複迴歸分析
  - 共線性診斷
    - 容忍值(Tolerance) (範圍0-1)
      - 愈大愈好，代表共線性問題愈小
    - 變異數膨脹因素 (VIF, variance inflation faction)
      - 愈小愈好，代表愈沒有共線性問題
    - 條件指標 (CI, condition index)
    - 自變項間相關係數>0.7 可能有共線性問題



共線性問題：
1. Tolerance < 0.1
2. VIF > 10
3. CI > 30

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	115.771	14.348		8.069	.000		
	age	-.004	.034	-.014	-.105	.917	.864	1.158
	sex	-1.384	.875	-.218	-1.582	.119	.778	1.286
	BMI	.634	.614	.149	1.033	.306	.707	1.415

a. Dependent Variable: SBP

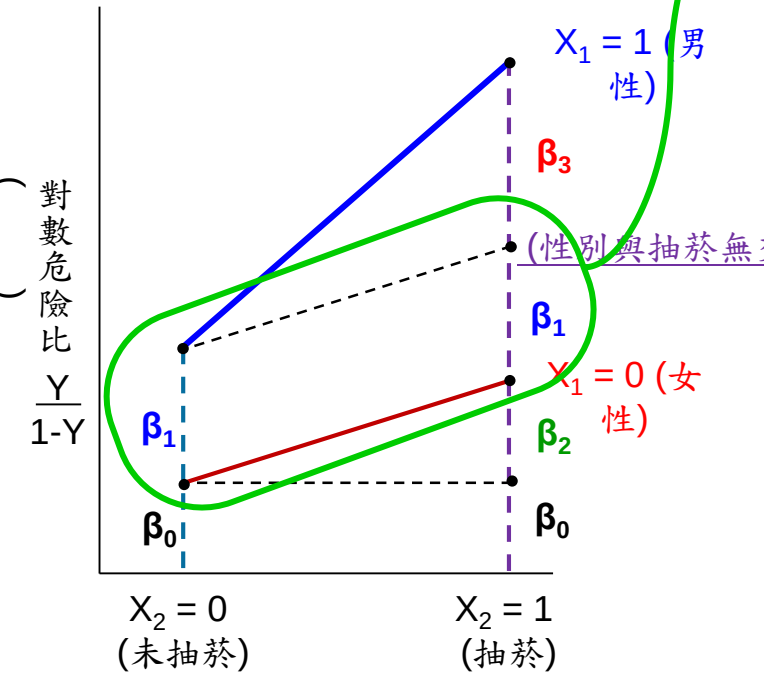
範例：Reg.xls-reg4.

Interaction

如果性別與抽菸之間並無交互作用存在，則$\boldsymbol{\beta_3 = 0}$，因此男女性有無抽菸的連線是互相平行的。

$$\ln\left(\frac{Y}{1-Y}\right) = \boldsymbol{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 (x_1 \cdot x_2)}$$

男性$X_1 = 1$，女性$X_1 = 0$
抽菸$X_2 = 1$，未抽菸$X_2 = 0$
$X_1 \cdot X_2$ 性別與抽菸的交互作用變項



抽菸與性別對於肺癌發生之獨立與交互作用

未抽菸女性之對數危險比為 $\ln\left(\frac{Y_{00}}{1-Y_{00}}\right) = \boldsymbol{\beta_0}$

未抽菸男性之對數危險比為 $\ln\left(\frac{Y_{10}}{1-Y_{10}}\right) = \boldsymbol{\beta_0 + \beta_1}$

抽菸女性之對數危險比為 $\ln\left(\frac{Y_{01}}{1-Y_{01}}\right) = \boldsymbol{\beta_0 + \beta_2}$

抽菸男性之對數危險比為 $\ln\left(\frac{Y_{11}}{1-Y_{11}}\right) = \boldsymbol{\beta_0 + \beta_1 + \beta_2 + \beta_3}$

陳建仁 (1999)。流行病學：原理與方法。聯經

Linear regression

- 範例三：年齡、性別及BMI值與收縮壓的相關性

ID	age	sex	BMI	SBP
01	70	0	23.2	134
02	76	1	23.3	127
03	84	1	23.4	128
04	85	1	23	131
05	47	1	23.6	129
…	…	…	…	…
…	…	…	…	…
61	52	0	23.2	130
62	55	0	24.4	124
63	71	0	24.6	131
64	56	0	23.7	130
65	70	0	24	135

範例四：年齡、性別、BMI等因子與收縮壓之相關性

	Simple linear regression			Multiple linear regression		
	B	95%CI	*p* value	B	95%CI	*p* value
Age	0.02	(-0.04 – 0.09)	0.487	-0.004	(-0.07 – 0.06)	0.917
Male	-1.81	(-3.34 – -0.28)	0.021	-1.38	(-3.13 – 0.37)	0.119
BMI	1.05	(0.01 – 2.08)	0.048	0.63	(-0.59 – 1.86)	0.306

Linear regression. *p<0.05, **p<0.01

範例：Reg.xls-reg4

Logistic regression

- 主要在探討以自變項 (Independent variable) 的變化來預測或解釋結果變項 (Dependent variable) 的變化。
- 目的要建立變數間的因果關係，以利預測結果
- 依變項為二元分類資料 (0 or 1) ⟶ 預測 1 的機率
  - 年齡與有無特定慢性病的關係
  - 吸菸與有無肺癌的關係
  - 嚼檳榔與有無口腔癌的關係
  - 醫師年資與手術成功與否的關係
- 自變項為類別變數或連續變數

Logistic regression

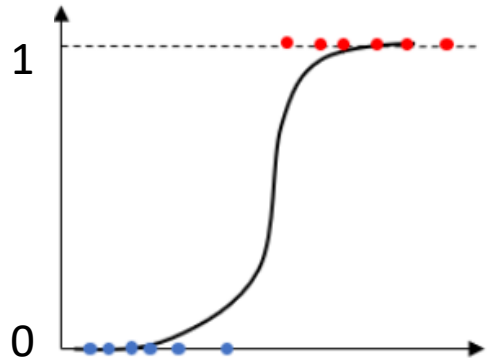
- 單變項迴歸表示式

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

- 多變項迴歸表示式

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

- 自變數 (X) 對依變數 (Y) 的影響是以指數的方式做變動，因此不需要常態分配的假設
- 使用「最大概似函數估計法 (Maximum Likelihood Estimation) 」做參數估計



From log odds to probability

Here's the equation of a logistic regression model with 1 predictor X:

a.k.a. **Log Odds**

or **Logit**

Intercept

$$\log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X$$

Where **P is the probability** of having the outcome and **P / (1-P) is the odds** of the outcome.

When X = 0, the intercept β_0 is the log of the odds of having the outcome

From log odds to probability

$$\ln \frac{p}{1-p} = \beta_0 + \beta_1 X \quad \rightarrow \quad \frac{P}{1-P} = e^{\beta_0 + \beta_1 X}$$

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

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

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

Odds ratio (OR)

		Outcome	
		Lung cancer	Control
Exposure	Smoking	a	b
	Non Smoking	c	d

$$\mathrm{OR} = \frac{a/c}{b/d} = \frac{ad}{bc}$$

Odds ratio	意義
OR=1	抽菸與肺癌無關
OR>1	抽菸可能為肺癌的危險因子
OR<1	抽菸可能為肺癌的保護因子

Logistic regression example-1

- 探討角膜生物力學特性預測青光眼的風險

Table 3. Logistic Regression Analyses for Predicting Primary Angle Closure Glaucoma

	Univariable		Multivariable	
Measurement	Odds Ratio (95% CI)	*P* Value	Odds Ratio (95% CI)	*P* Value
Age (years)	1.120 (1.070–1.173)	<0.001	1.067 (0.982–1.159)	0.126
Sex (Male)	0.293 (0.148–0.581)	<0.001	0.350 (0.100–1.223)	0.100
CCT (μm)	0.980 (0.970–0.990)	<0.001	0.996 (0.974–1.018)	0.700
IOP (mm Hg)	0.898 (0.814–0.991)	0.032	0.959 (0.796–1.154)	0.656
ACV (mm^3)	0.947 (0.931–0.964)	<0.001	0.950 (0.929–0.971)	<0.001
CBiF	0.021 (0.006–0.079)	<0.001	0.029 (0.003–0.266)	0.002

Translational Vision Science & Technology, 2022, 11.10: 7-7.

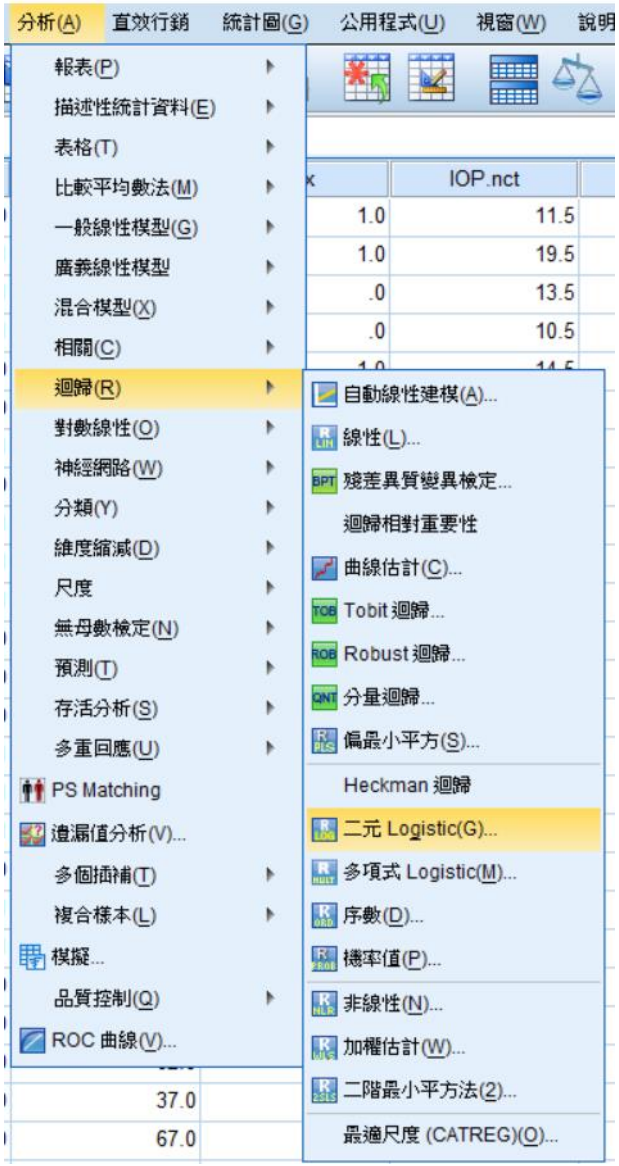
Logistic regression SPSS dataset

Outcome (0 or 1)

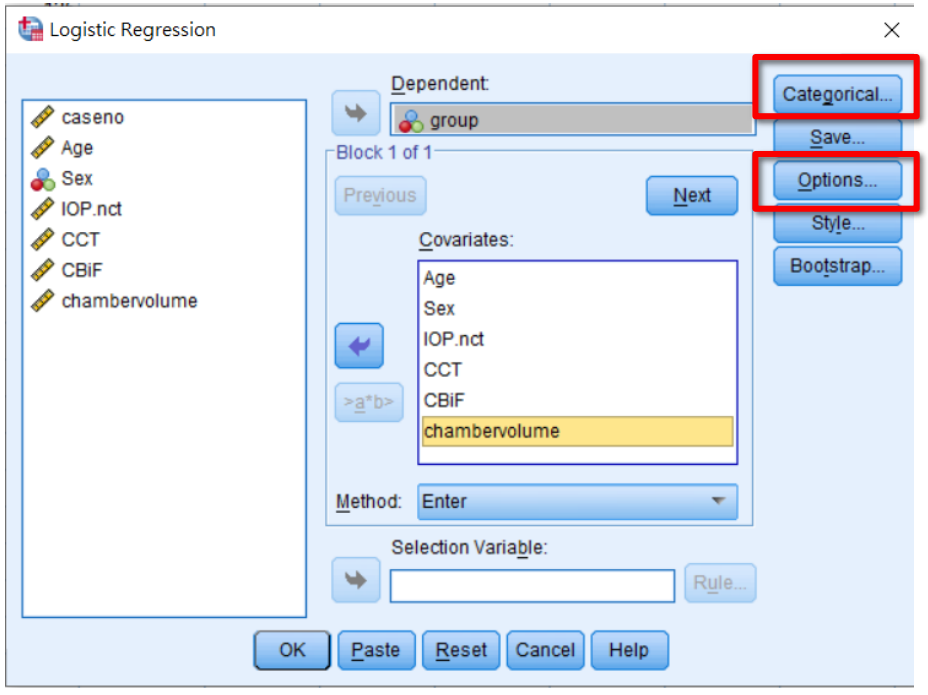
caseno	group	Age	Sex	IOP.nct	CCT	CBiF
1	0	82.0	1.0	11.5	523	.
2	1	77.0	1.0	19.5	532	6.522
3	1	75.0	.0	13.5	641	5.845
4	1	76.0	.0	10.5	523	6.024
5	0	72.0	1.0	14.5	557	6.246
6	0	73.0	.0	18.0	571	6.946
7	1	69.0	.0	12.5	535	5.031
8	0	79.0	.0	14.0	553	6.385
9	1	68.0	1.0	18.5	549	6.441
10	1	68.0	1.0	17.5	542	6.162
11	1	78.0	1.0	14.0	541	6.723
12	0	62.0	.0	14.5	591	6.490
13	0	70.0	1.0	14.5	557	6.283
14	0	79.0	1.0	16.5	534	6.416
15	1	63.0	1.0	18.0	549	6.435

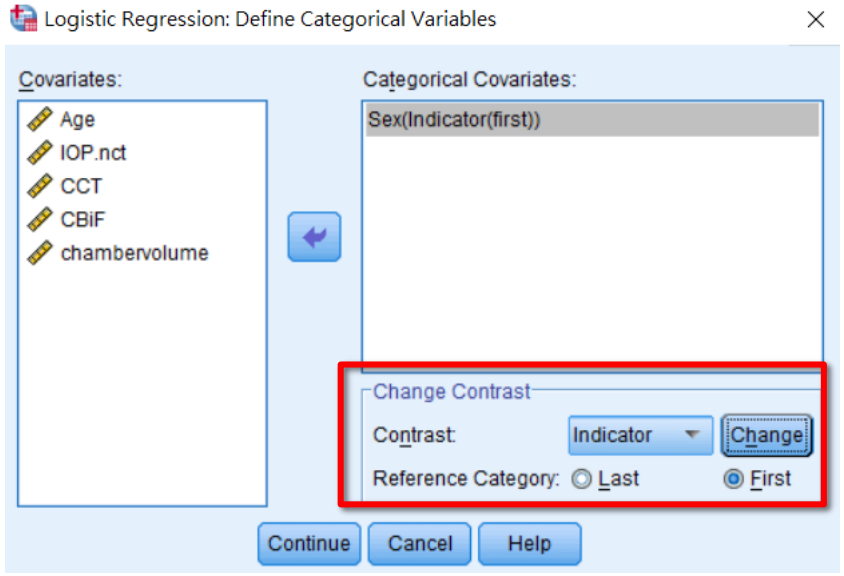
Logistic regression SPSS analysis-1

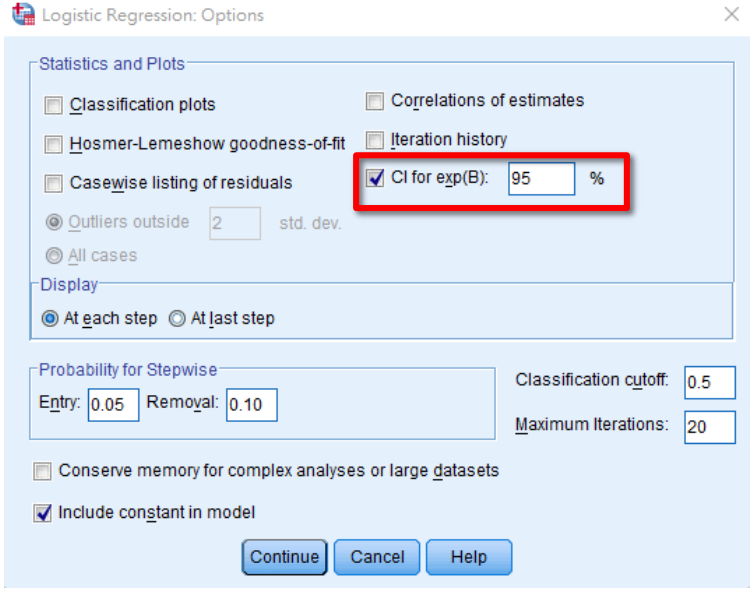
分析>迴歸>二元Logistic



Logistic regression SPSS analysis-2







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]	Age	.065	.042	2.341	1	.126	1.067	.982	1.159
	Sex(1)	-1.051	.639	2.706	1	.100	.350	.100	1.223
	IOP.nct	-.042	.095	.198	1	.656	.959	.796	1.154
	CCT	-.004	.011	.149	1	.700	.996	.974	1.018
	CBiF	-3.534	1.127	9.829	1	.002	.029	.003	.266
	ACV	-.052	.011	20.907	1	.000	.950	.929	.971
	Constant	26.788	8.046	11.084	1	.001	4.304E+11		

a. Variable(s) entered on step 1: Age, Sex, IOP.nct, CCT, CBiF, ACV.

經多變項調整後，
CBiF每增加1個單位罹患青光眼的風險降低 0.029 倍
且達統計差異 (p=0.002) 。

Logistic regression example-2

- 探討Brain Image對於大腦皮質下區域失智症的影響
  - Adjusted model
    - age, sex and CCI

TABLE 5 | Associations of imaging variables with subcortical vascular dementia, $N = 57$.

	Dementia	
	OR (95%CI)	***p***
MARS		
Infratentorial	1.00 (0.93–1.07)	0.963
Deep	1.03 (0.99–1.08)	0.161
Lobar	1.00 (0.99–1.02)	0.739
Total	1.00 (0.99–1.01)	0.580
ARWMC		
Infratentorial	0.53 (0.10–2.80)	0.458
Basal ganglia	1.67 (0.74–3.78)	0.221
Subcortical	2.03 (1.24–3.32)	0.005*
Total	1.43 (1.09–1.89)	0.011*
PVSE		
Centrum semiovale	0.72 (0.36–1.42)	0.339
Basal ganglia	1.10 (0.44–2.74)	0.837
Lesion quantity		
ICH	1.00 (0.75–1.34)	1.000
Lacune	1.18 (1.02–1.35)	0.023*
Lesion burden score		
CAA-SVD score	2.33 (1.01–5.40)	0.047*
C1†	1.41 (1.09–1.83)	0.009*
C2‡	1.38 (1.08–1.76)	0.010*

ICH, intracerebral hemorrhage; MARS, Microbleed anatomical rating scale; ARWMC, Age-related White Matter Change; PVSE, enlargement of the perivascular space; CAA, cerebral amyloid angiopathy; SVD, small vessel disease; OR, odd's ratio.

*ORs determined by multivariate logistic regression, adjusted for age, sex, and CCI; *$p < 0.05$.*

†*Sum of total MARS score and total ARWMC scale.*

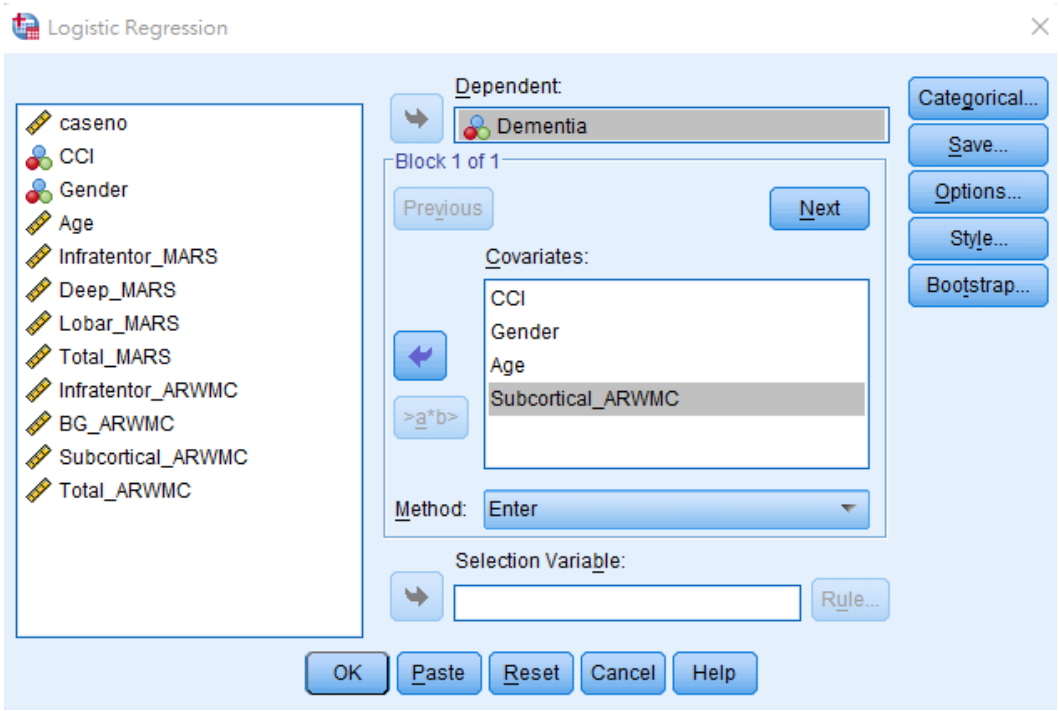
‡*Sum of total MARS score, total ARWMC scale, BG PVSE (≥20), and lacune (≥5).*

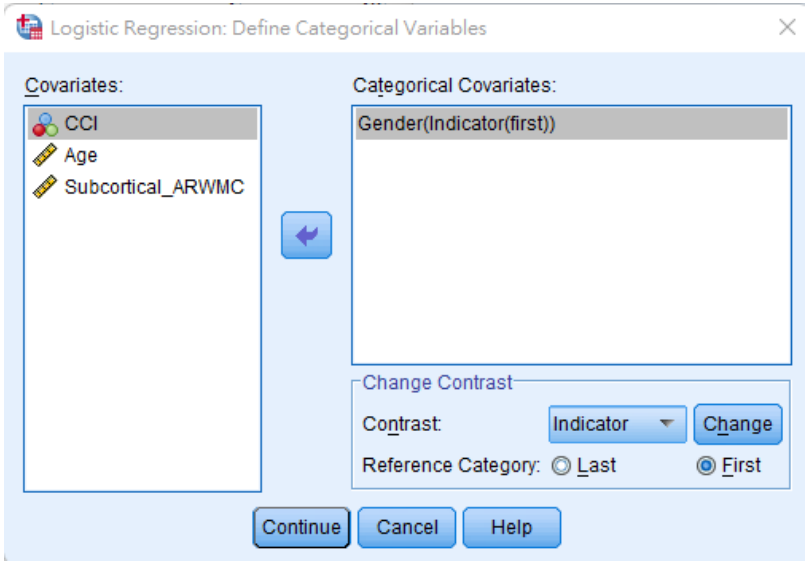
Frontiers in Neurology 12 (2021)

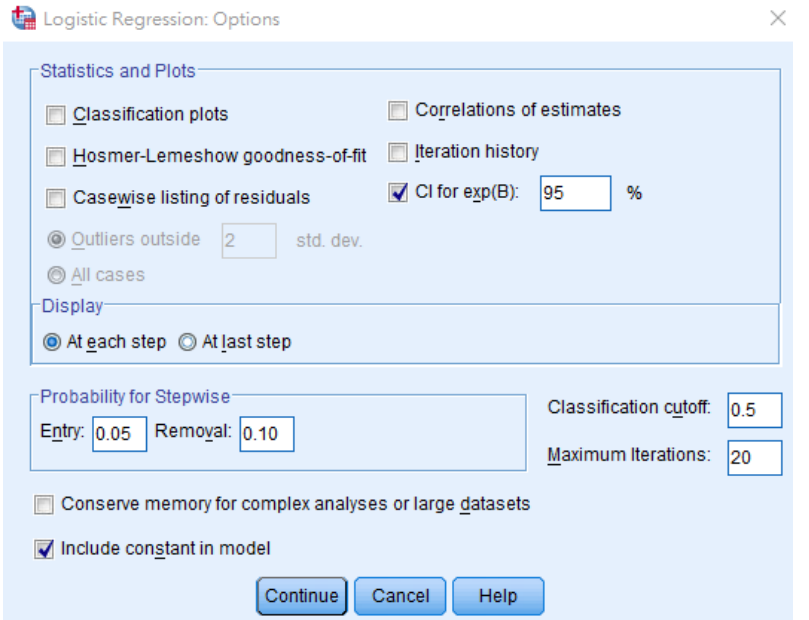
Logistic regression SPSS dataset

	caseno	Dementia	CCI	Gender	Age	Infratentor_MARS	Deep_MARS	Lobar_MARS	Total_MARS
1	1	1	4	1	87	6	4	11	21
2	2	0	6	1	99	.	.	.	.
3	3	0	5	1	72	0	2	10	12
4	4	0	2	0	82	14	10	17	41
5	5	0	1	1	80	1	7	5	13
6	6	0	3	1	54	12	21	120	153
7	7	1	2	1	64	0	12	56	68
8	8	1	4	1	61	6	5	1	12
9	9	0	5	1	72	37	43	176	256
10	10	0	3	1	63	1	1	1	3
11	11	0	1	0	89	3	3	5	11
12	12	0	2	1	88	8	19	5	32

Logistic regression SPSS analysis







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]	CCI	-.119	.295	.163	1	.687	.888	.498	1.583
	Gender(1)	.287	.824	.122	1	.727	1.333	.265	6.700
	Age	.005	.036	.022	1	.883	1.005	.936	1.079
	Subcortical_ARWMC	.708	.251	7.920	1	.005	2.029	1.240	3.322
	Constant	-5.365	3.040	3.114	1	.078	.005		

a. Variable(s) entered on step 1: CCI, Gender, Age, Subcortical_ARWMC.

經性別、年齡和CCI調整後，
Subcortical_ARWMC每增加1個單位罹患失智症的風險增加 2.029 倍且達統計差異 (p=0.005) 。

基礎醫學科生統小組：統計方法教育訓練

4/22問卷

臺中榮民總醫院 心臟血管研究中心

Thank you for listening