Contents

	Pref	ace	page xiii
1	Intr	oduction	1
	1.1	Why should I do multivariable analysis?	1
	1.2	What are confounders and how does multivariable analysis	
		help me to deal with them?	6
	1.3	What are suppressers and how does multivariable analysis help me to deal with them?	9
	1.4	What are interactions and how does multivariable analysis help	
		me to deal with them?	11
2	Con	nmon uses of multivariable models	14
	2.1	What are the most common uses of multivariable models in	
		clinical research?	14
	2.2	How do I choose what type of multivariable analysis to use?	23
3	Out	come variables in multivariable analysis	24
	3.1	How does the nature of my outcome variable influence my	
		choice of which type of multivariable analysis to do?	24
	3.2	What type of multivariable analysis should I use with an	
		interval outcome?	24
	3.3	What are the different types of analysis of variance and when	
		are they used?	25
	3.4	What should I do if my outcome variable is ordinal or nominal?	27
	3.5	What type of multivariable analysis should I use with a	
		dichotomous outcome?	20

vili	Conten	ts	
		What type of multivariable analysis should I use with a time-to-outcome variable?	28
	3.7	What type of multivariable analysis should I use with a rare outcome or a count?	32
4	Туре	of independent variables in multivariable analysis	35
Account of the second s		What type of independent variables can I use with multivariable analysis?	35
		What should I do with my ordinal and nominal independent variables?	35
5	Assur logis	mptions of multiple linear regression, multiple tic regression, and proportional hazards analysis	38
	5.1	What are the assumptions of multiple linear regression, multiple logistic regression, and proportional hazards analysis?	38
	5.2	What is being modeled in multiple linear regression, multiple logistic regression, and proportional hazards analysis?	38
	5.3	What is the relationship of multiple independent variables to outcome in multiple linear regression, multiple logistic regression, and proportional hazards analysis?	42
	5.4	What is the relationship of an interval-independent variable to the outcome in multiple linear regression, multiple logistic regression, and proportional hazards analysis?	43
	5.5	What if my interval-independent variable does not have a linear relationship with my outcome?	46
	5.6	Assuming that my interval-independent variable fits a linear assumption, is there any reason to group it into interval categories or create multiple dichotomous variables?	51
	5.7	What are the assumptions about the distribution of the outcome and the variance?	52
	5.8	What should I do if I find significant violations of the assumptions of normal distribution and equal variance in my	55
	5.9 5.10	multiple linear regression analysis? What are the assumptions of censoring? How likely is it that the censoring assumption is valid	56
	5.10	in my study?	59

ix	Contents		
	5.11	How can I test the validity of the censoring assumption for my data?	64
6	Rela	tionship of independent variables to one another	68
	6.1	Does it matter if my independent variables are related	
		to each other?	68
	6.2	How do I assess whether my variables are multi collinear?	69
	6.3	What should I do with multicollinear variables?	71
7	Setti	ng up a multivariable analysis	73
	7.1	What independent variables should I include in my multivariable model?	73
	7.2	How do I decide what confounders to include in my model?	73
	7.3	What independent variables should I exclude from my	
	7.4	multivariable model?	74
	7.4	How many subjects do I need to do multivariable analysis?	77
	7.5	What if I have too many independent variables given my sample size?	81
	7.6	What should I do about missing data on my independent variables?	87
	7.7	What should I do about missing data on my outcome variable?	94
8	Perfe	orming the analysis	96
	8.1	What numbers should I assign for dichotomous or ordinal variables in my analysis?	96
	8.2	Does it matter what I choose as my reference category for	
		multiple dichotomous ("dummied") variables?	97
	8.3	How do I enter interaction terms into my analysis?	98
	8.4	How do I enter time into my proportional hazards or other survival analysis?	101
	8.5	What about subjects who experience their outcome on their start date?	106
	8.6	What about subjects who have a survival time shorter than	100
	0.0	physiologically possible?	107
	8.7	What are variable selection techniques?	109
	8.8	What value should I specify for tolerance in my logistic	,
		regression or proportional hazards model?	114

Contents

	8.9	How many iterations (attempts to solve) should I specify for	114
		my logistic regression or proportional hazards model?	114
	8.10	What value should I specify for the convergence criteria for	115
		my logistic regression or proportional hazards model?	115
	8.11	My model won't converge. What should I do?	115
9	Inter	preting the analysis	117
	9.1	What information will the printout from my analysis provide?	117
	9.2	How do I assess how well my model accounts for the outcome?	117
	9.3	What do the coefficients tell me about the relationship	
	7.5	between each variable and the outcome?	124
	9.4	How do I get odds ratios and relative hazards from the	
	7.1	multivariable analysis? What do they mean?	126
	9.5	How do I interpret the odds ratio and relative hazard when the	
	7.0	independent variable is interval?	129
	9.6	How do I compute the confidence intervals for the odds ratios	
	,,,	and relative hazards?	130
	9.7	What are standardized coefficients and should I use them?	131
	9.8	How do I test the statistical significance of my coefficients?	131
	9.9	How do I interpret the results of interaction terms?	134
	9.10		
	,,,,,	for multiple comparisons?	134
10	Che	cking the assumptions of the analysis	137
	10.1	How do I know if my data fit the assumptions of my	
	10.1	multivariable model?	137
	10.2	the state of the s	
	10.2	variance assumptions of multiple linear regression?	138
	10.0	- 1 1: '	
	10.3	regression and proportional hazards analysis?	139
		te 11 1 1 1 1 1 and the combine many multiple	
	10.4		139
		linear regression model?	107
	10.5		141
		model?	
	10.6		142
		analysis?	142
	10.7	What should I do when I detect outliers?	174

i		
•	SACTORISE ALCOHOMICS	

	10.8	What is the additive assumption and how do I assess whether	
		my multiple independent variables fit this assumption?	143
	10.9	What does the additive assumption mean for	
		interval-independent variables?	145
	10.10	What is the proportionality assumption?	146
	10.11	How do I test the proportionality assumption?	148
	10.12	What if the proportionality assumption does not hold for	
		my data?	150
11	Prope	ensity scores	153
	11.1	What are propensity scores? Why are they used?	153
12	Corre	lated observations	158
	12.1	How do I analyze correlated observations?	158
	12.2	How do I calculate the needed sample size for studies with	
		correlated observations?	177
13	Valida	ation of models	179
	13.1	How can I validate my models?	179
14	Speci	al topics	184
	14.1	What if the independent variable changes value during the course of the study?	184
	14.2	What are the advantages and disadvantages of	
		time-dependent covariates?	185
	14.3	What are classification and regression trees (CART) and	
		should I use them?	187
	14.4	How can I get best use of my biostatistician?	190
	14.5	How do I choose which software package to use?	190
15	Publis	shing your study	192
	15.1	How much information about how I constructed my multivariable models should I put in the Methods section?	192
	15.2	Do I need to cite a statistical reference for my choice of	172
		multivariable model?	194

	Contents		
	15.3	Which parts of my multivariable analysis should I report in the Results section?	194
16	Sum	mary: Steps for constructing a multivariable model	197
	Inde	K	199