STATISTICAL BRIEFING: ODDS AND ODDS RATIOS

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Odds are a method for representing probability that will be familiar to anyone who gambles. The odds are the ratio of the probability that something will occur divided by the probability that it will not. In the case of a single throw of a die, the odds of throwing a six may be described as one to five (0.2, 20%). Note that this is not the same as the probability of throwing a six, which is one in six (0.17, 17%).

Odds can be used to summarize the relationship between exposure to a risk factor (e.g., etiologic agent, clinical sign, or history) and outcome (e.g., presence or absence of disease). Odds ratios (OR) are frequently used to summarize the results of cross-sectional or case–control studies.[1,2]

	Outcome	
Exposure	Yes	No
Yes	a	b
No	c	d

Odds of outcome in exposed patients, a/b; odds of exposure in patients with outcome, a/c.

Data extracted from a recent study of dogs with cauda equina syndrome (CES)[3] can be used to illustrate use of odds.

	Outcome	
Exposure	CES	No CES
Male	65	1870
Female	27	2130

Odds of a dog with CES being male = 65/27 = 2.4; CES, cauda equina syndrome.

Clinicians often want to know whether a risk factor is associated with the occurrence of a particular disease. Recognizing such an association could aid work-up and diagnosis, and might reflect the cause of the disease. For example, one of the reasons to perform the study of dogs with CES was to determine if being a male dog, being a German Shepherd dog, or having a transitional lumbosacral vertebra is associated with development of CES. This question may be answered using OR. The OR represents the relative magnitude of the odds of an outcome among exposed individuals in comparison with the odds of the same outcome in unexposed individuals. Using data from the study of CES (Table 1), OR for males = 2.7, OR for German Shepherd dogs = 3.2, and OR for transitional lumbosacral vertebra = 5.3. These results describe the strength of the associations between CES and being male, being a German shepherd, and having a transitional lumbosacral vertebra, respectively.

Table 1. Odds Ratios of Potential Predisposing Factors in Dogs with Cauda Equina Syndrome[3]

Factor	Dogs with CES ($n = 92$)	Control Dogs ($n = 4000$)	Odds Ratio
Male	65	1870	
Female	27	2130	
$Odds_{male}$	65/27 = 2.4	1870/2130 = 0.88	2.4/0.88 = 2.7
German Shepherd	37	684	
Non-German shepherd	55	3316	
$Odds_{GSD}$	37/55 = 0.67	684/3316 = 0.21	0.67/0.21 = 3.2
Transitional lumbosacral vertebra	15	138	
Normal vertebrae	77	3862	
$Odds_{TLV}$	15/77 = 0.19	138/3862 = 0.036	0.19/0.036 = 5.3

Table 2. Results of Multiple Logistic Regression Analysis Dogs with Cauda Equina Syndrome[3]

Factor	Odds Ratio	95% Confidence Interval
Male	2.1	(1.1–3.9)
German Shepherd	8.3	(4.5–15.6)
Transitional lumbosacral vertebra	8.4	(3.7–18.9)

However, in a study such as this, in which there are multiple possible risk factors, it is necessary to take account of the possibility that particular combinations of factors may interact. To take account of these possible interactions between factors it is necessary to analyze these particular data using multiple logistic regression (Table 2). This tests the possibility of an interaction by including a multiplicative term between the factors in a mathematical model and then comparing OR values for particular

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factors with and without this term in the model. When multiple logistic regression is done using the data from the CES study, it is apparent that the OR for transitional lumbosacral vertebra (8.4 vs. 5.3) and German shepherd dog (8.3 vs. 3.2) are greater than expected on the basis of the individual calculations, whereas being male has a lower OR (2.1 vs. 2.7).

OR are normally stated with their 95% confidence intervals, which indicate the degree of uncertainty about the estimated OR. In Table 2 it is apparent that the lower limit of the 95% confidence interval for the OR for being male is only 1.1. Because the 95% confidence interval for the OR is close to 1, there might be no effect of being male.

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