Government of Alberta
Health and Wellness

UNIVERSITY OF CALGARY

Logistic Regression: Use & Interpretation of Odds Ratio (OR)

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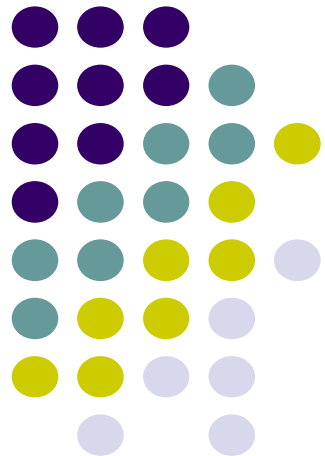


Background

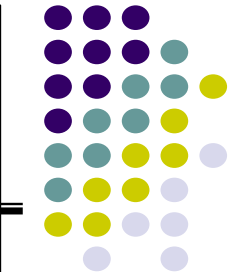
- **Odds: The ratio of the probability of occurrence of an event to that of nonoccurrence.**

- **Odds ratio (OR, relative odds): The ratio of two odds, the interpretation of the odds ratio may vary according to definition of odds and the situation under discussion.**

- **Consider the 2x2 table:**

	Event	Non-Event	Total
Exposure	a	b	a+b
Non-Exposure	c	d	c+d
Total	a+c	b+d	N

A 2x2 Table for Two Binary Variables



	Lung Ca	No Lung Ca	Total
Smoking	**80**	**20**	100
Non-Smoking	**20**	**80**	100
Total	100	100	200

Odds for Lung Cancer$_{\text{smokers}}$ = 80/20=4.00

- The probability of having lung cancer among smokers is 4 times of not having lung cancer.

Odds Ratio for Lung Cancer$_{\text{smokers}}$ = (80/20) / (20/80) =16.00

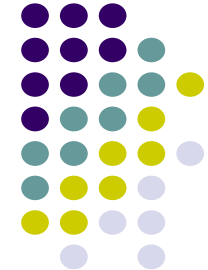
- The probability of developing lung cancer among smokers is 16 times of that non-smokers.

Why is the odds ratio useful?

If the odds measures exposure-disease relationship

- Determine the strength of association: Strong (OR>3), moderate (OR=1.6-3.0), weak (OR=1.1-1.5)
- Assess the impact of confounding variables
- Estimate the relative risk for a disease in relation to a given risk factor

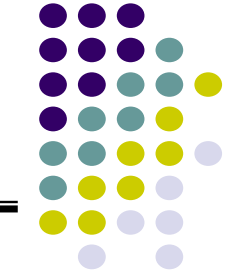
Why is the odds ratio useful (cont'd)?



If the odds measures other event to non-event (reference) relationship or spatial/temporal trend

- The likelihood to delivery LBW babies for mothers 35 years or older is 2.5-times of that for mothers 20-34 years
- The rate of MVA in Northern Alberta is 4 times more than that in Calgary
- The rate increased 2-folds, from 3 per 100,000 population in 1990 (reference) to 9 per 100,000 in 2010

Why Do We Need Logistic Regression?



- LBW was reported high in our region. Is it true?
- What are the factors that contribute to a lower rate?
- Tell me what will be the LBW rate in next 20 years in our region.

Logistic Procedure

- Logistic regression models the relationship between a binary or ordinal response variable and one or more explanatory variables.

- **Logit $(P_i)=\log\{P_i/(1-P_i)\}= \alpha + \beta\ 'X_i$**

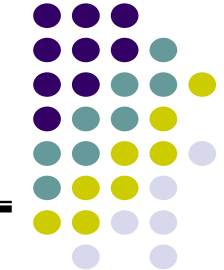
where P_i = response probabilities to be modeled

α = intercept parameter

β = vector of slope parameters

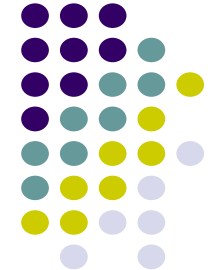
X_i = vector of explanatory variables

Performing a Logistic Regression



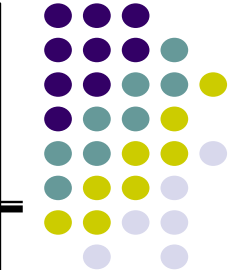
```
Proc logistic data = sample;
    Class mage_cat;

    Model       LBW = year mage_cat drug_yes drink_yes
                      smoke_9 smoke_yes /
                      lackfit outroc=roc2;

    Output out=Probs Predicted=Phat;
run;
```

Why Re-Coding Data to Binary?



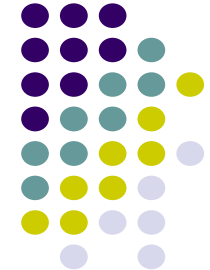
- While explanatory variables can be continuous and ordinal types, it is useful to recode them into binary sometime.
- When we want to use a fixed group as the reference, coding a variable into binary makes it easier to use and interpret.
- Teen age mother vs. mother 20-34 years or mother 35+ vs. mother 20-34 years, for instance.

Re-Coding Data to Binary



```
data sample;
   set &srcData;
Smoke_Yes=0;   Smoke_9=0;       Drug_Yes=0;
Drink_Yes=0;       Mage_Teen=0;    Mage_Old=0;

if EverSmoke = 1              then Smoke_Yes= 1;
if EverSmoke in (9, .)        then Smoke_9    = 1;
if Street_Drug = 1            then Drug_Yes   = 1;
if ALCOHOL_Preg= 1            then Drink_Yes   = 1;

if Mage_cat= 2                then Mage_Old   = 1;
if Mage_cat= 0                then Mage_Teen = 1;  run;
```

Understanding Distribution – Proc Freq



```
Proc freq data=sample; table smoke_yes*LBW/nopercent
    nocol chisq cmh1;

Proc freq data=sample; table smoke_yes*(Mage_Teen
    Mage_Old mage_cat)/nopercent norow chisq cmh1;

Proc freq data=sample; table smoke_yes*(drug_yes
    drink_yes)/nopercent chisq;

run;
```

Run the Macros for Data Preparation

- %inc '\\edm-goa-file-3\user$\fu-lin.wang\methodology\Logistic Regression\recode_macro.sas';
- %***recode***;

Distribution of Maternal Smoking and LBW

Low Birth Weight (< 2500 g)

Maternal Smoking	1 (Yes) n=68	0 (No) n=932
1 (n=237)	11.0%	89.0%
0 (n=763)	5.5%	94.5%

Odds Ratio (95%CI): 2.11 (1.27-3.53)

Use Class Statement for Odds Ratio

```
Proc logistic data = sample desc outest=betas2;
   Class mage_cat;

   Model LBW =  year mage_cat drug_yes drink_yes
                smoke_9 smoke_yes /
                lackfit outroc=roc2;

   Output out=Probs_2 Predicted=Phat;
run;
```

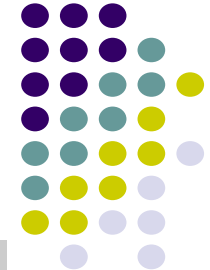
Use Recoded Data for Odds Ratio

```
Proc logistic data = sample desc outest=betas3;

   Model LBW =  year mage_Teen Mage_Old
                drug_yes drink_yes
                smoke_9 smoke_yes /
                lackfit outroc=roc3;

   Output out=Probs_3  Predicted=Phat;
run;
```

Run the Macros for logistic regression

- %inc '\\edm-goa-file-3\user$\fu-lin.wang\methodology\Logistic Regression\logistic_macro.sas';

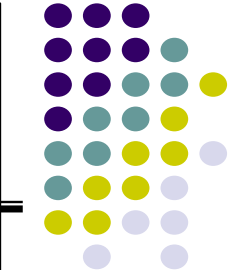
Logistic Regression - Class Statement



Odds Ratio Estimates

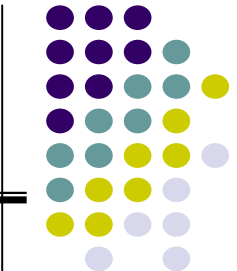
Effect	Point Estimate	95% Wald Confidence Limits	
YEAR	0.951	0.850	1.064
mage_cat 0 vs 2	0.313	0.105	0.927
mage_cat 1 vs 2	0.405	0.226	0.724
Drug_Yes	0.494	0.102	2.381
Drink_Yes	2.047	0.797	5.258
Smoke_9	1.506	0.548	4.135
Smoke_Yes	2.384	1.338	4.247

Logistic Regression - Recoded Data



	Odds Ratio Estimates		
Effect	Point Estimate	95% Wald Confidence Limits	
YEAR	0.951	0.850	1.064
Mage_Teen	0.773	0.286	2.089
Mage_Old	2.472	1.382	4.421
Drug_Yes	0.494	0.102	2.381
Drink_Yes	2.047	0.797	5.258
Smoke_9	1.506	0.548	4.135
Smoke_Yes	2.384	1.338	4.247

Logistic Regression - Model Fitness



Model Fit Statistics

Criterion	Intercept Only	Intercept & Covariates
AIC	498.869	492.644
SC	503.777	531.906
-2 Log L	496.869	476.644

Identical for AIC, SC and -2 Log L

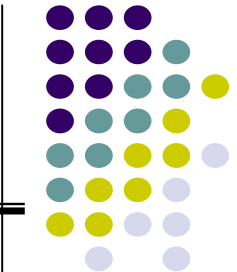
and other statistics between two models

Association of Predicted Probabilities and Observed Responses

Percent Concordant	63.4	Somers' D	0.306
Percent Discordant	32.9	Gamma	0.317
Percent Tied	3.7	Tau-a	0.039
Pairs	63376	c	0.653

Goodness-of- Fit Test: P=0.132

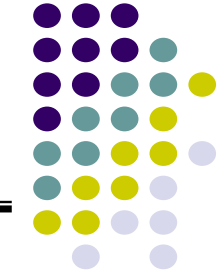
Impact of Excluding Missing Smoking



Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
YEAR	0.961	0.862	1.071
Mage_Teen	0.785	0.290	2.124
Mage_Old	2.439	1.365	4.357
Drug_Yes	0.487	0.101	2.349
Drink_Yes	2.047	0.797	5.260
Smoke_Yes	2.288	1.299	4.028

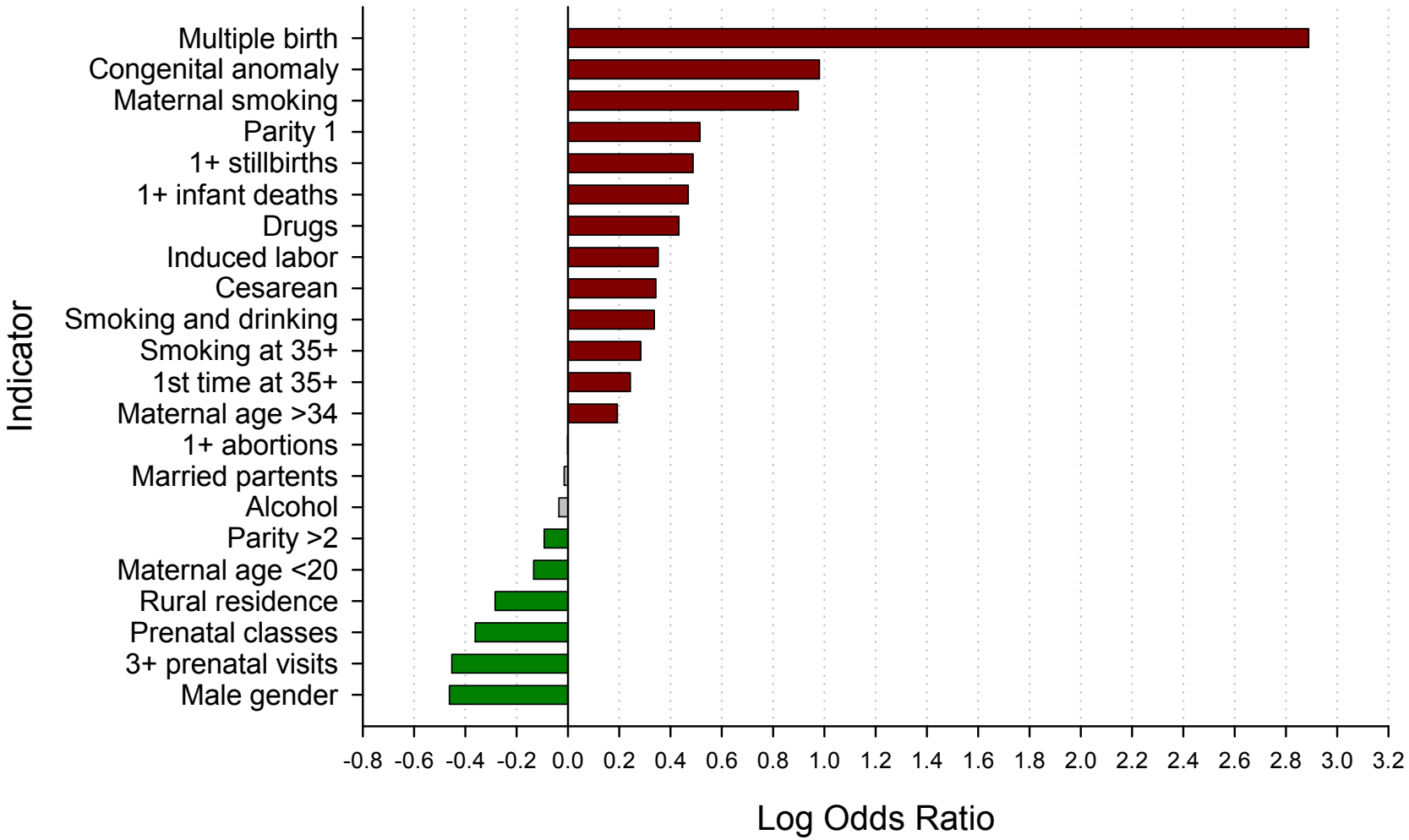
OR reduced from 2.38 to 2.29

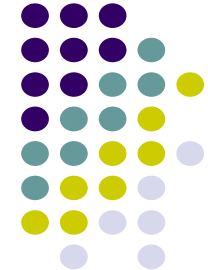
Interpretation of OR in Logistic Regression



- There is a moderate association between maternal smoking and LBW.
- Maternal age is associated with both LBW and maternal smoking.
- After controlling the confounding effect of maternal age (and other variables in the model), the risk for LBW among pregnant women who smoke is about 2.4 times of that non-smoking pregnant women.

Predictors of Low Birth Weight in Term Livebirths, Alberta, 1997 to 2004





Questions?

Pease contact:

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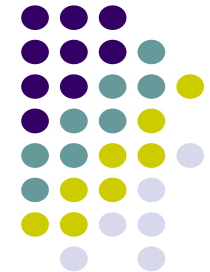

Thank you!!