JMP as a Teaching Tool for Visualizing Data for an Online Multimedia Public Health Learning Module

JMP Discovery Summit

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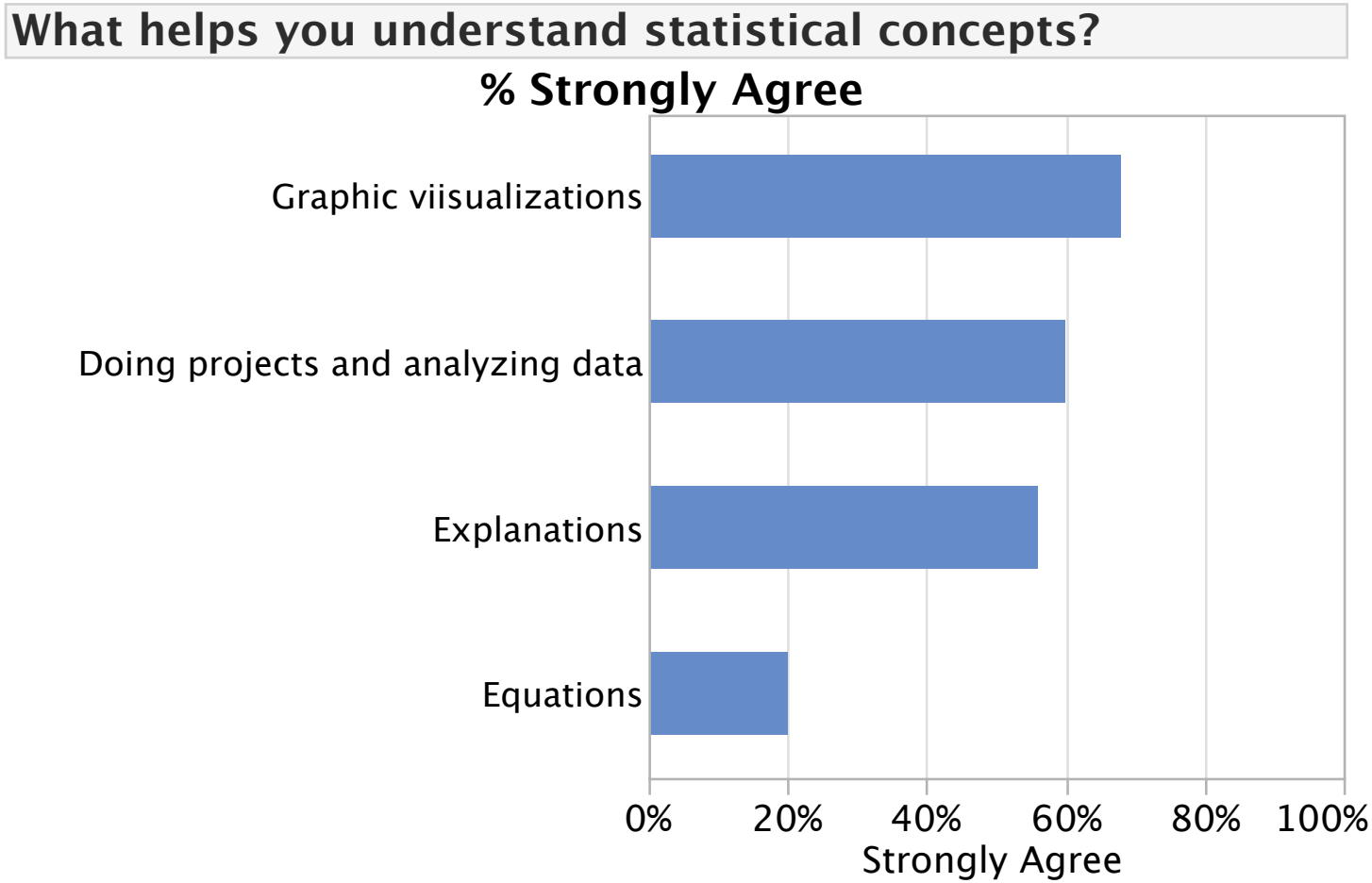
September 11, 2013

Outline

- JMP as a teaching tool
- The educational goals
- What we did
- What’s next

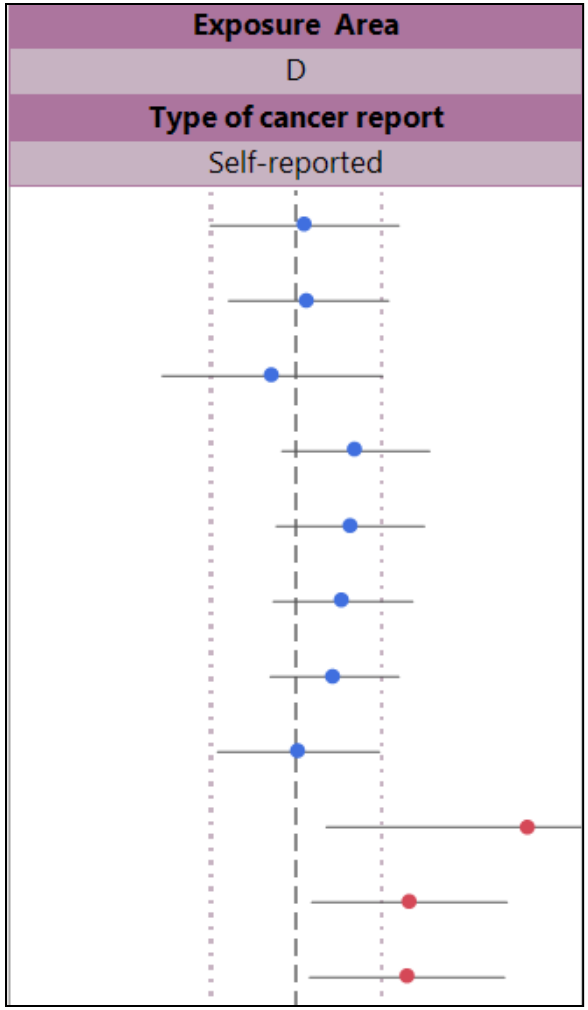
What my students say…



HSPH class, n=27

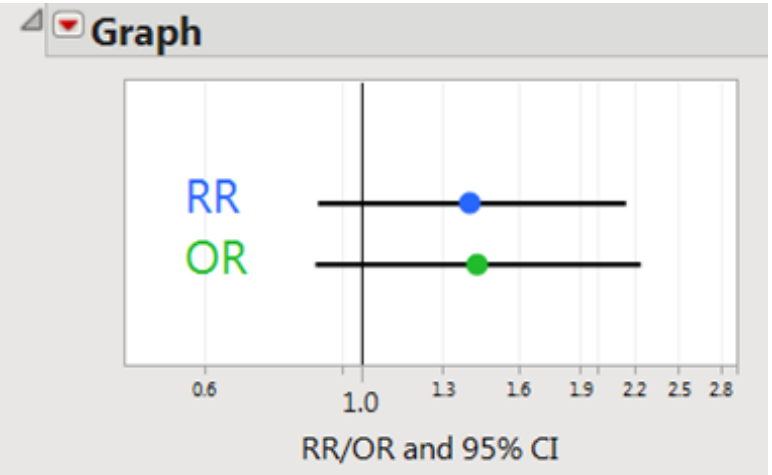
JMP as a Teaching Tool

- Visualization
  - To detect patterns in the data
  - To build expertise in reading graphics
  - To understand statistical concepts



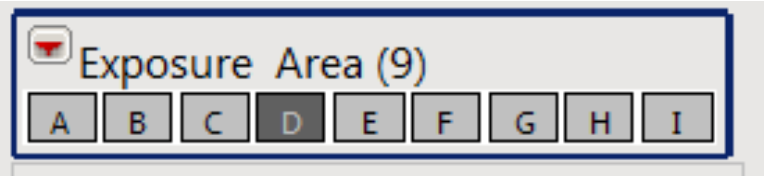
JMP as a Teaching Tool

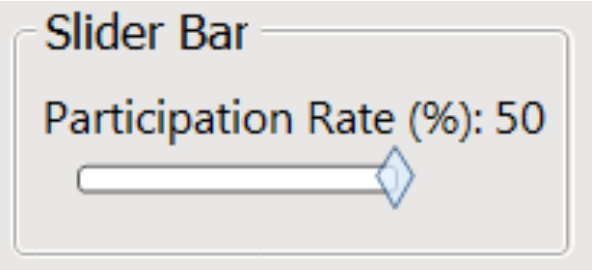
- Simulations and demonstrations
  - To explore concepts



JMP as a Teaching Tool

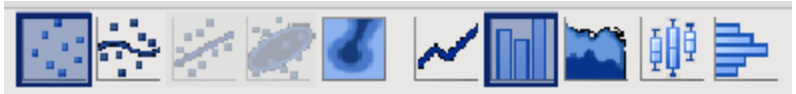
- User controlled (interactive) exploration





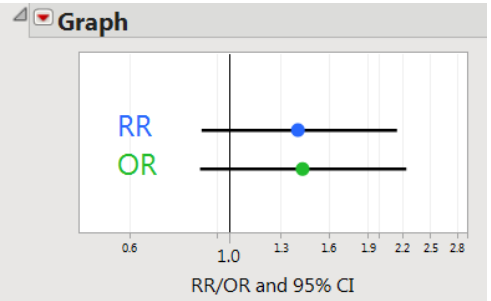
JMP Features Used

Graph Builder



Local data filter

Interactive JSL script



The challenge

Develop a teaching module for Public Health courses.

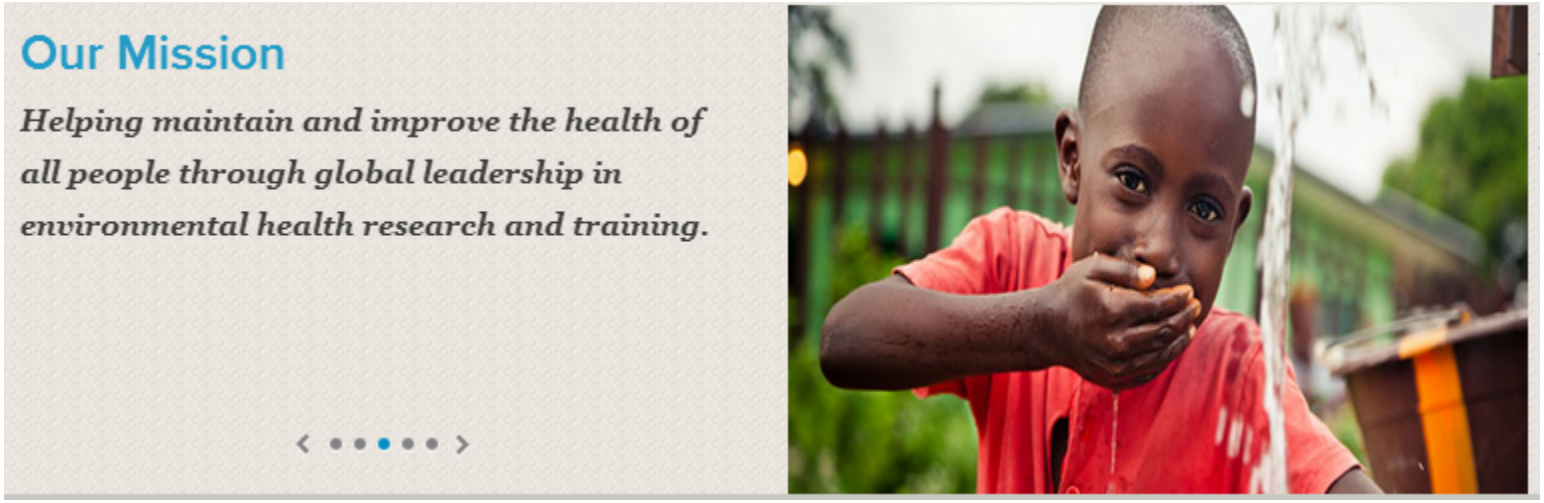
- Online
- Case-based
- Multimedia
- Interactive
- **Effective for teaching scientific, statistical, and epidemiological concepts**

The audience

- Students at the Harvard School of Public Health
  - Masters of Public Health
  - Masters of Health Care Management
- Mostly Physicians

The Subject Content

- Environmental Health
  - Reported disease clusters
  - Routes of exposure



The Subject Content

- Epidemiology
  - Study design
  - Interpretation of study results
  - Understanding Relative Risks and Odds Ratios

	Disease	
Exposed	Yes	No
Yes	a	b
No	c	d

HILT | Harvard Initiative for Learning & Teaching

Transforming stories and public health lessons of Ashland, MA, into a multimedia case for learning

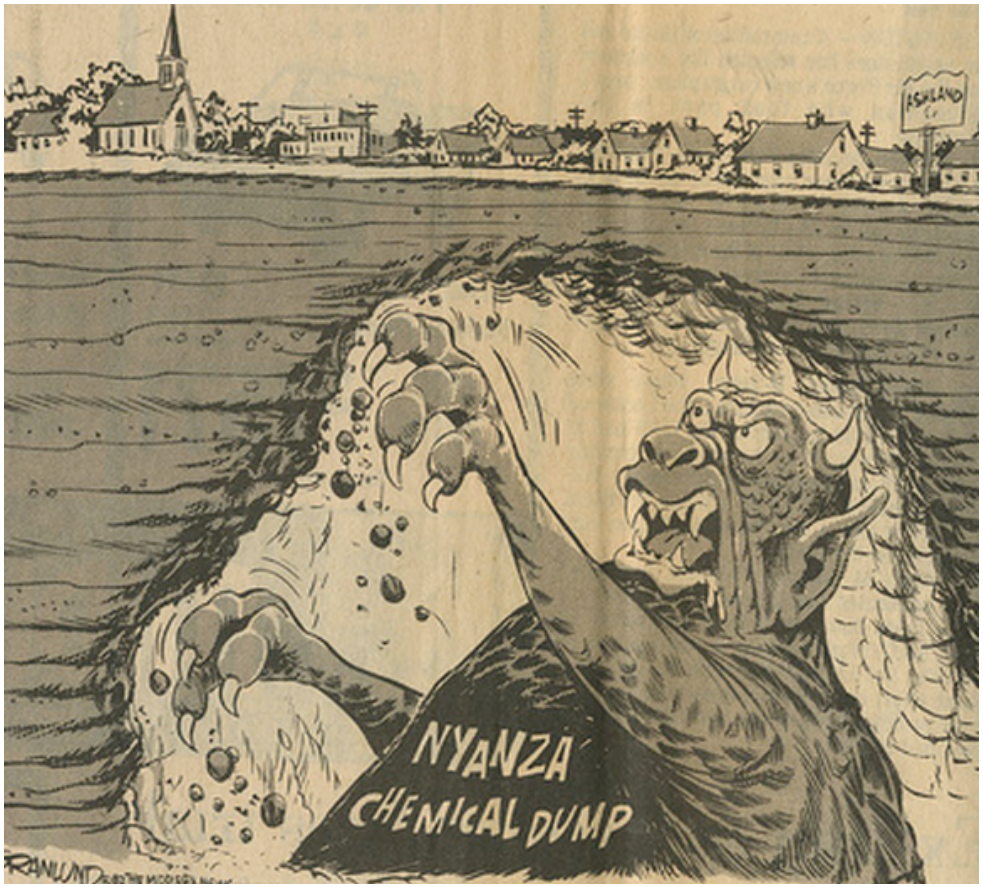
Rose H. Goldman (SPH), Amy Cohen (SPH), Dan Borelli (GSD), Kara Oehler (Other), Jesse Shapins (GSD)

Awardees created (using Zeega software) a multimedia "case" that better integrates quantitative and qualitative information, for use in a public health course (and other settings) and serves as a model for next-generation case-based teaching.

Thanks to HILT for grant funding.

The case: A cancer cluster?

The case relates the story a community's concern that toxic waste from a Superfund site is causing rare cancers in young people.



http://zeega.com/69241

The case: A cancer cluster?

The story begins with a call to MDPH from Kevin Kane, 25 years old.

He reports that he has been diagnosed with a rare cancer.

Four other young men from his high school also have rare cancers.

The case: A cancer cluster?

The public health official has to determine if and how to follow-up on the call.

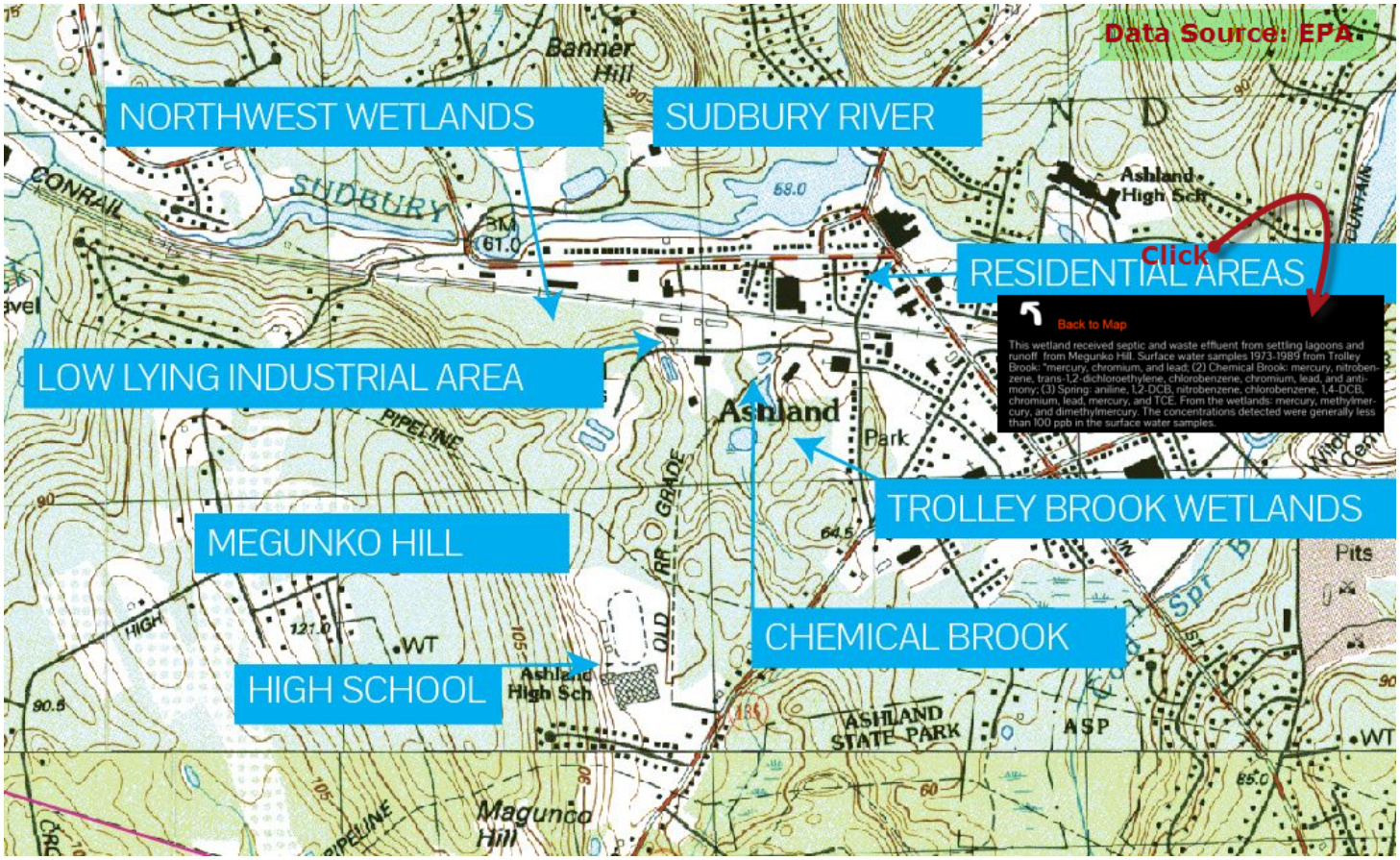
Ashland Nyanza Health Study

Final Report

April 2006

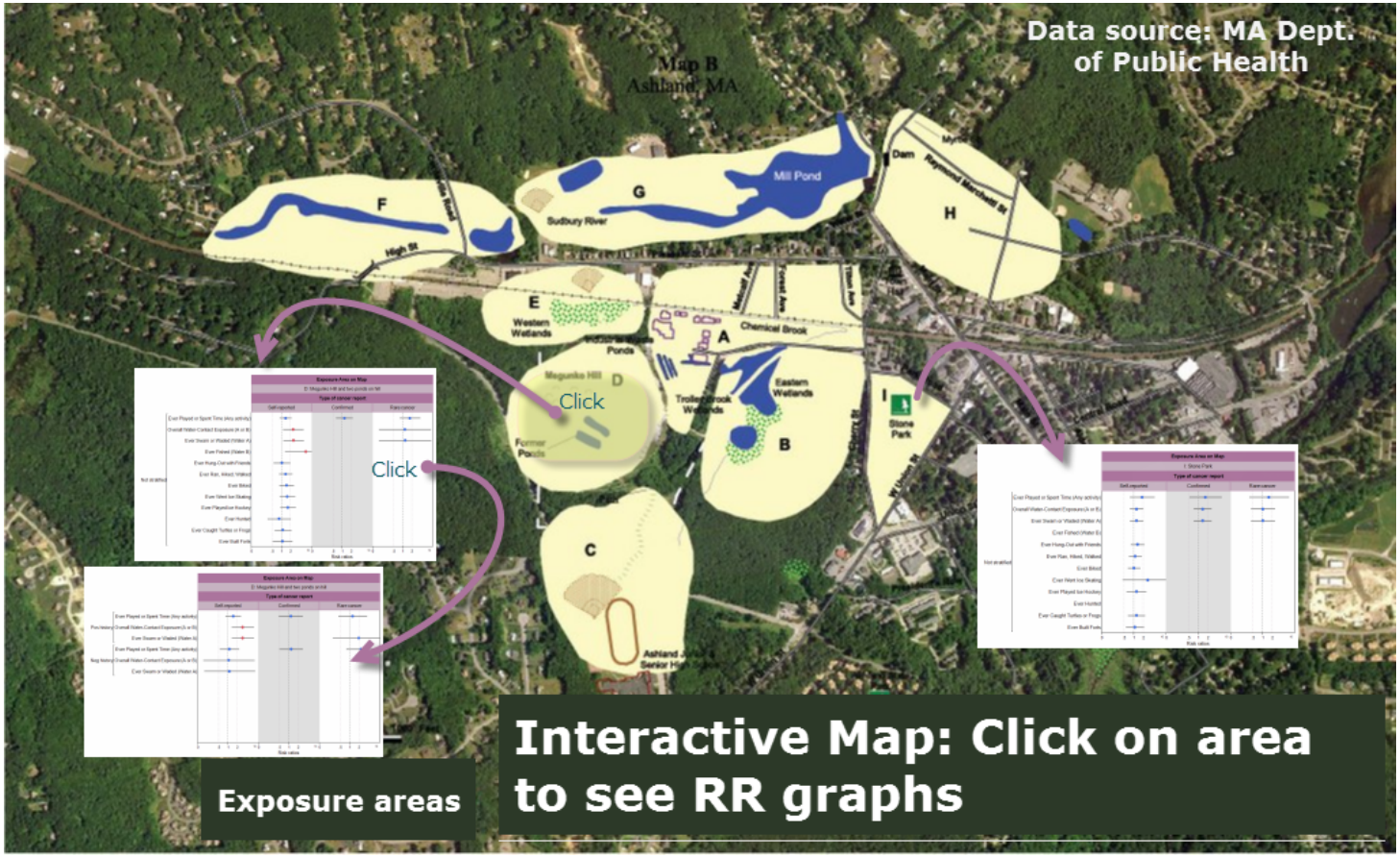
Massachusetts Department of Public Health
Center for Environmental Health

EPA Report


Data Source: EPA
NORTHWEST WETLANDS
SUDBURY RIVER
RESIDENTIAL AREAS
Click
Back to Map
This wetland received septic and waste effluent from settling lagoons and runoff from Megunko Hill. Surface water samples 1973-1989 from Trolley Brook: "mercury, chromium, and lead; (2) Chemical Brook: mercury, nitrobenzene, trans-1,2-dichloroethylene, chlorobenzene, chromium, lead, and antimony; (3) Spring: aniline, 1,2-DCB, nitrobenzene, chlorobenzene, 1,4-DCB, chromium, lead, mercury, and TCE. From the wetlands: mercury, methylmercury, and dimethylmercury. The concentrations detected were generally less than 100 ppb in the surface water samples.
LOW LYING INDUSTRIAL AREA
TROLLEY BROOK WETLANDS
MEGUNKO HILL
CHEMICAL BROOK
HIGH SCHOOL
Banner Hill
SUDBURY
CONRAIL
Ashland High Sch
Ashland
Park
PIPELINE
GRADE
OLD
RR
HIGH
Pits
ASHLAND STATE PARK
ASP
Magunco Hill
WT


Data Source: EPA
NORTHWEST WETLANDS
SUDBURY RIVER
RESIDENTIAL AREAS
LOW LYING INDUSTRIAL AREA
Ashland
TROLLEY BROOK WETLANDS
MEGUNKO HILL
CHEMICAL BROOK
HIGH SCHOOL

MDPH Report


Data source: MA Dept. of Public Health
Map B
Ashland, MA
Mill Pond
Sudbury River
Dam
F
G
H
E
Western Wetlands
Chemical Brook
A
Megunko Hill
D
Eastern Wetlands
Trolley Brook Wetlands
B
I
Stone Park
C
Click
Click
Exposure areas
Interactive Map: Click on area to see RR graphs

Discussion Questions

- Is there a cancer cluster in Ashland?
- Is there an association between the Nyanza site and cancer?
- As the public health commissioner at the Department of Health, how would you communicate the results to the residents?

JMP used for:

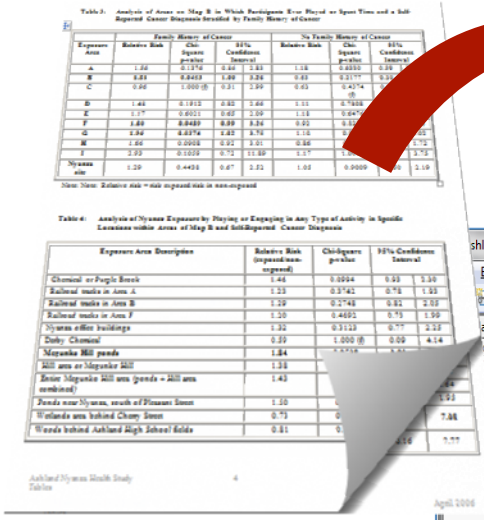
1. Interactive Trellis graphs to communicate risk estimates by exposure pathway and geographic area.

JMP used for:

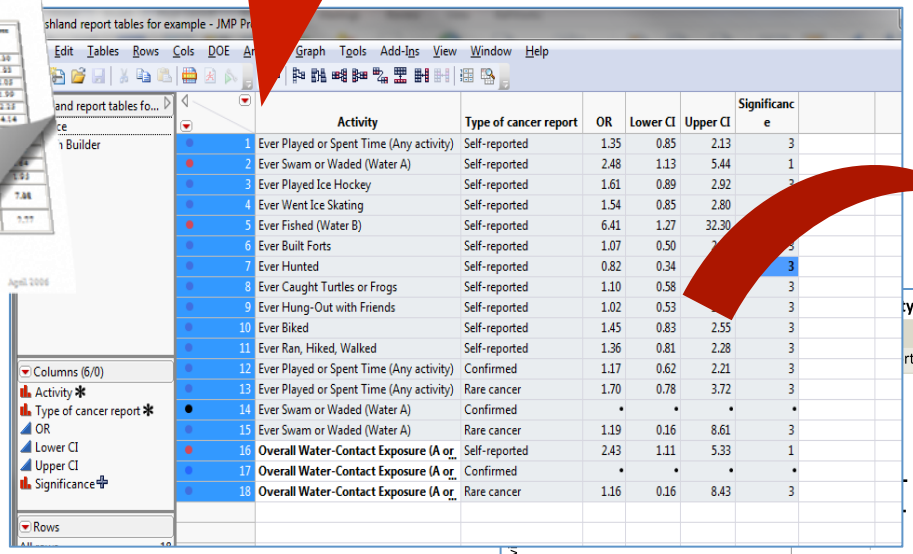
1. Interactive Trellis graphs to communicate risk estimates by exposure pathway and geographic area.
2. Interactive JSL script to simulate scenarios to illustrate epidemiologic associations.

Interactive Trellis graphs

[Click to go to Zeega]

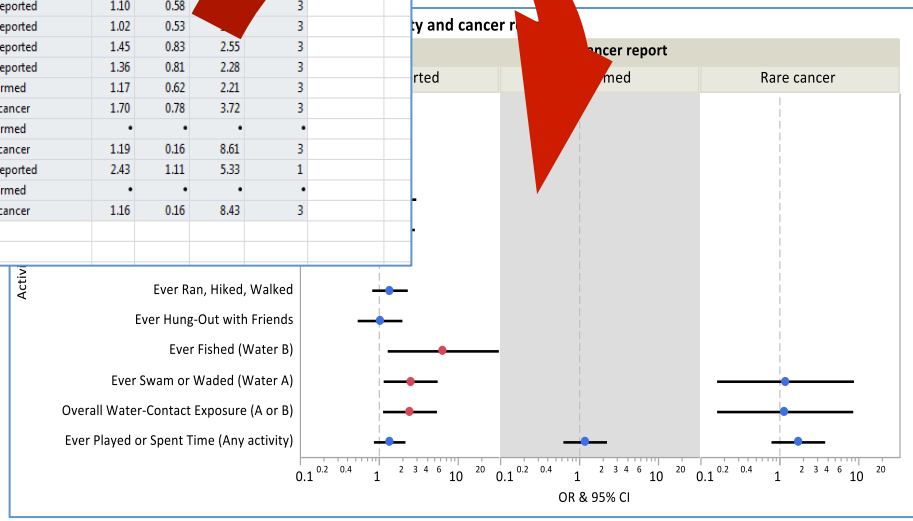


Results in 29 pages of reports

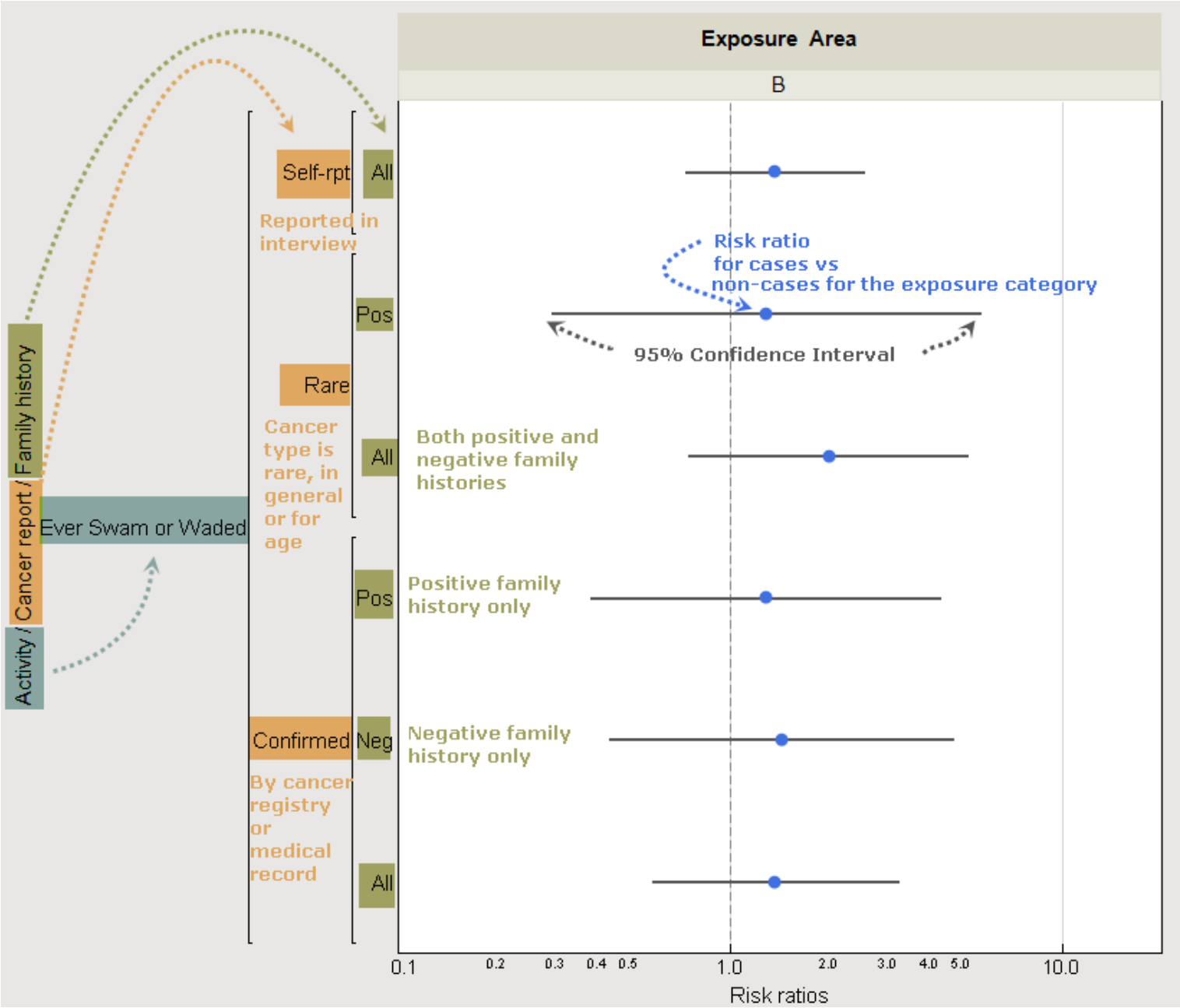


	Activity	Type of cancer report	OR	Lower CI	Upper CI	Significance
1	Ever Played or Spent Time (Any activity)	Self-reported	1.35	0.85	2.13	3
2	Ever Swam or Waded (Water A)	Self-reported	2.48	1.13	5.44	1
3	Ever Played Ice Hockey	Self-reported	1.61	0.89	2.92	3
4	Ever Went Ice Skating	Self-reported	1.54	0.85	2.80	
5	Ever Fished (Water B)	Self-reported	6.41	1.27	32.30	
6	Ever Built Forts	Self-reported	1.07	0.50		3
7	Ever Hunted	Self-reported	0.82	0.34		3
8	Ever Caught Turtles or Frogs	Self-reported	1.10	0.58		3
9	Ever Hung-Out with Friends	Self-reported	1.02	0.53		3
10	Ever Biked	Self-reported	1.45	0.83	2.55	3
11	Ever Ran, Hiked, Walked	Self-reported	1.36	0.81	2.28	3
12	Ever Played or Spent Time (Any activity)	Confirmed	1.17	0.62	2.21	3
13	Ever Played or Spent Time (Any activity)	Rare cancer	1.70	0.78	3.72	3
14	Ever Swam or Waded (Water A)	Confirmed	•	•	•	•
15	Ever Swam or Waded (Water A)	Rare cancer	1.19	0.16	8.61	3
16	Overall Water-Contact Exposure (A or	Self-reported	2.43	1.11	5.33	1
17	Overall Water-Contact Exposure (A or	Confirmed	•	•	•	•
18	Overall Water-Contact Exposure (A or	Rare cancer	1.16	0.16	8.43	3

Data transferred to JMP



Trellis graphs created


Exposure Area
B
Activity / Cancer report / Family history
Ever Swam or Waded
Self-rpt
Reported in interview
Rare
Cancer type is rare, in general or for age
Confirmed
By cancer registry or medical record
All
Pos
All
Pos
Neg
All
Risk ratio for cases vs non-cases for the exposure category
95% Confidence Interval
Both positive and negative family histories
Positive family history only
Negative family history only
0.1
0.2
0.3
0.4
0.5
1.0
2.0
3.0
4.0
5.0
10.0
Risk ratios

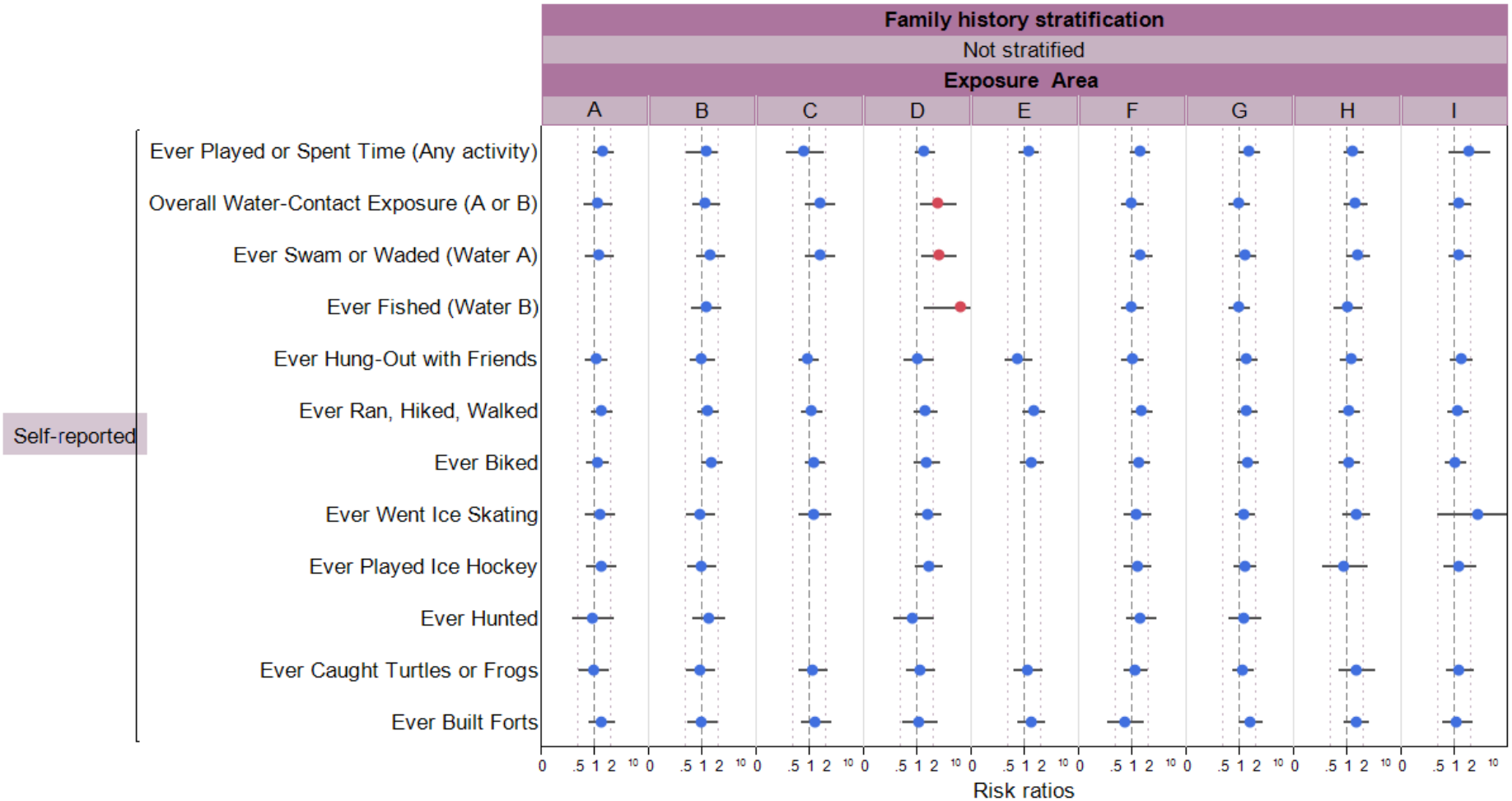
JMP: Graph Builder and Local Filter

Demonstration showing:

- Results calculated in 4 dimensions
- Graph Builder: Forest graphs to compare 95%CIs and point estimates
- Significance marked by color
- Local data filter: to present data in various configurations

All areas, self-reported, not stratified

[All in 1]



JMP: Interactive simulation

Explore epidemiologic associations - are they due to:

- Chance
- Bias
- Confounding
- Truth

Explore epidemiologic associations: Simulated scenarios in JMP

- What if MDPH Study had full participation?
- What if 50% of the cancer cases died before MDPH Study ?
- What if exposed people were twice as likely to participate ?
- What if only 40 confirmed cancer cases included ?

Relative Risks & Odds Ratios

	Disease	
Exposed	Yes	No
Yes	a	b
No	c	d

Odds Ratio = (a*d)/(c*b)

Relative Risk = (a/(a+b))/(c/(c+d))

JSL

```
/*OR 95% CI written in terms of a, b, c, and d*/
U95_OR = Exp(ln((a*d)/(c*b)) + (1.96*Root((1/a)+(1/b)+(1/c)+(1/d),2)));
L95_OR = Exp(ln((a*d)/(c*b)) - (1.96*Root((1/a)+(1/b)+(1/c)+(1/d),2)));

/*Confidence intervals for RR
Ln_RR = ln(Relative_Risk);
Var_lnRR = ((b/a)/(a+b))+ ((d/c)/(c+d));
SE_lnRR = Root(Var_lnRR,2);
U95_RR = Exp(Ln_RR + (1.96*SE_lnRR));
L95_RR = Exp(Ln_RR - (1.96*SE_lnRR));*/

/*RR 95%CI's written in terms of a, b, c, and d*/
U95_RR = Exp(ln((a/(a+b))/(c/(c+d))) + (1.96*Root(((b/a)/(a+b))+ ((d/c)/(c+d)),2)));
L95_RR = Exp(ln((a/(a+b))/(c/(c+d))) - (1.96*Root(((b/a)/(a+b))+ ((d/c)/(c+d)),2)));

/*List expressions to be evaluated*/
New_OR = Expr((a/sv) * (d/sv)/((c/sv) * (b/sv)));
New_U95_OR = Expr(Exp(ln(((a/sv)*(d/sv))/((c/sv)*(b/sv))) + (1.96*Root((1/(a/sv)+1/(b/sv)+1/(c/sv)+1/(d/sv)),2))));
New_L95_OR = Expr(Exp(ln(((a/sv)*(d/sv))/((c/sv)*(b/sv))) - (1.96*Root((1/(a/sv)+1/(b/sv)+1/(c/sv)+1/(d/sv)),2))));

New_RR = Expr((a*(1/sv) /(a*(1/sv) + b*(1/sv)))/(c*(1/sv)/(c*(1/sv) + d*(1/sv))));
New_U95_RR = Expr(Exp(ln((a*(1/sv)/(a*(1/sv)+b*(1/sv)))/(c*(1/sv)/(c*(1/sv)+d*(1/sv)))) + 1.96 * Root( (((b*(1/sv))/(a*(1/sv)
New_L95_RR = Expr(Exp(ln((a*(1/sv)/(a*(1/sv)+b*(1/sv)))/(c*(1/sv)/(c*(1/sv)+d*(1/sv)))) - 1.96 * Root( (((b*(1/sv))/(a*(1/sv)


/*Can add more panel boxes, graphs, text boxes, etc...*/

nw = New Window( "Ashland",
    H List Box(
    Spacer Box(Size(10,10)),
    Panel Box( "Ashland Participation Rates Demo",

    V List Box(Outline Box("Inputs",
                H List Box(
            tb2 = Text Edit Box("a = "|| Char(a)),
            tb3 = Text Edit Box("b = "|| Char(b))
```

Ashland Participation Rates Demo

Inputs

a = 36	b = 547
c = 36	d = 767

Change to Inputs

a =	b =
c =	d =

Odds Ratio and 95% CI

Initial	New
OR = 1.40	OR =
Upper 95% CI = 2.25	Upper 95% CI =
Lower 95% CI = 0.87	Lower 95% CI =

Relative Risk and 95% CI

Initial	New
RR = 1.38	RR =
Upper 95% CI = 2.16	Upper 95% CI =
Lower 95% CI = 0.88	Lower 95% CI =

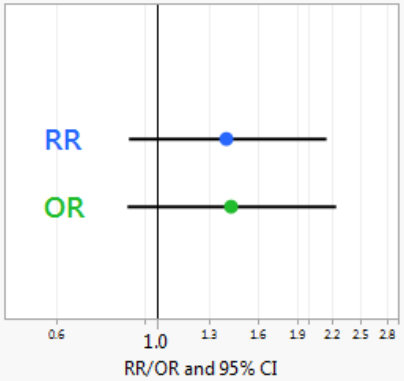
Slider Bar

Participation Rate (%): 100

Close

Graphs of OR's and RR's

Graph



Ashland Participation Rates Demo

Inputs

a = 36	b = 547
c = 36	d = 767

Change to Inputs

a = 124	b = 1886
c = 124	a = 2645

Odds Ratio and 95% CI

Initial	New
OR = 1.40	OR = 1.40
Upper 95% CI = 2.25	Upper 95% CI = 1.81
Lower 95% CI = 0.87	Lower 95% CI = 1.09

Relative Risk and 95% CI

Initial	New
RR = 1.38	RR = 1.38
Upper 95% CI = 2.16	Upper 95% CI = 1.75
Lower 95% CI = 0.88	Lower 95% CI = 1.08

Slider Bar

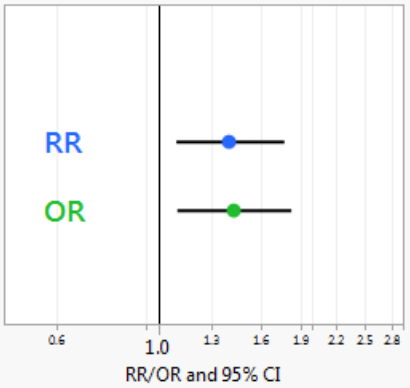
Participation Rate (%): 29

0.29

Close

Graphs of OR's and RR's

Graph



Courses so far…

- Principles of Environmental Health (EH202)
  - Professor Doug Dockery (Chair of the EH Dept.)
- Case studies in EH and Epidemiology (HCM705)
  - Profs. Marc Weisskoph (EH & EPI) and Karin Michels (EPI)
- Introduction to EH (EH201)
  - Prof. Rose Goldman, MD (EH, project leader)

Student feedback

Q: Were media useful for understanding the case?

% agree or strongly agree

The video interviews	100%
The sequence of maps showing land use	95%
The interactive maps	100%

*"The case really came to life. Enjoyed the video clips … **and appreciated the ability to delve into the data via the interactive maps."***

Next…

- Local data filter for iPad in JMP11
- Interactive HTML in JMP11 (link)
- Add features to the demo script for additional scenarios
- “The students need to learn to design and create these visualizations themselves”
  - Professor Dockery

Next…

- Integrate **data analysis** with JMP into the biostatistics and epidemiology curriculum
- First experiment in ID207, intensive 3-week course in biostats and epi
  - Did JMP help you learn the statistical and epidemiological concepts? (n=47)
    - **Agree or strongly agree: 100%**

Thank You

- Questions?

- Contact us
  - Amy Cohen acohen@hsph.harvard.edu
  - Rima Habre rimahabre@gmail.com

Wednesday, 11:30 a.m. - 12:00 p.m.

JMP® as a Teaching Tool for Visualizing Data for an Online Multimedia Public Health Learning Module

Amy Cohen, Director of Educational Research and Assessment, Harvard School of Public Health
Rima Habre, ScD, Postdoctoral Research Fellow, Harvard School of Public Health

Lone Star C | Topic: Data Visualization | **Level:**

For an environmental health course at the Harvard School of Public Health, we used JMP to teach statistical and epidemiological concepts in a multimedia case study about a cancer cluster in a community. We created visualizations of study results and an interactive simulation that served as educational technologies to enhance learning. Using the Graph Builder and the Local Data Filter, we were able to dynamically create 22 ***graphic displays*** to communicate the results in an engaging format suitable for online viewing. After creating one master graph comprising Forest plots arranged within Trellis graphs and with extensive customizations, several subset variations were easily produced. The graphs enabled visual comparison of the results by ***geographic area***, exposure activity and outcome. We also used JSL to simulate the effect of study participation rates on observed odds ratios and to display the impact ***visually***. Using a slider bar to vary participation rates, the viewer can observe the changes in sample sizes in two-by-two tables. A graphical display illustrates the impact on the 95 percent confidence intervals as participation rates vary. One hundred percent of students in the course reported that the visualizations helped them understand the study results and the underlying concepts.