Course VII-2, 2017

Basic statistical tests
Hypothesis testing

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What you can learn in this session

- Choosing an appropriate test
- Ways of tabulation
- Analyzing using OpenEpi
- Understanding hypothesis testing
- Interpreting results from descriptive analysis

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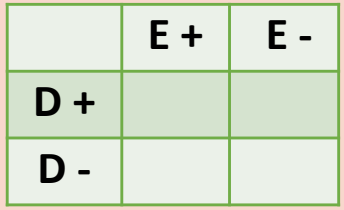
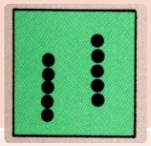
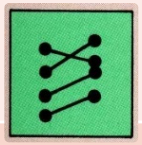
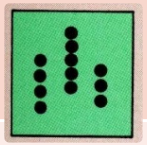
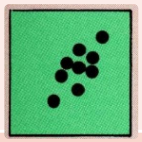
Basic statistical tests

Data type	Parametric	Non-parametric
Contingency table 		Large sample Chi-square test Small sample Fisher's exact test
Comparison of means		
(2 groups, independent) 	T-test	Mann-Whitney U test
(2 groups, paired) 	Paired t-test	Wilcoxon signed rank test
(≥3 groups, independent) 	ANOVA	Kruskal-Wallis test
Association of two continuous variables 		
(Correlation)	Pearson's correlation	Spearman's correlation
(Regression)	Linear regression	Median regression

❖Analysis of contingency table

Relationship of residential region and hypertension

	City A	City B
HP positive	20	80
HP negative	40	60

❖Comparison of means

Relationship of residential region and blood pressure

	City A	City B
max BP (mean)	160	140

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- Paired

  Before-after study

  Matched case-control

	Before treatment N=100	After treatment N=100
max BP (mean)	160	140

- Un-paired (independent)

	Placebo N=100	Drug A N=100
max BP (mean)	160	140

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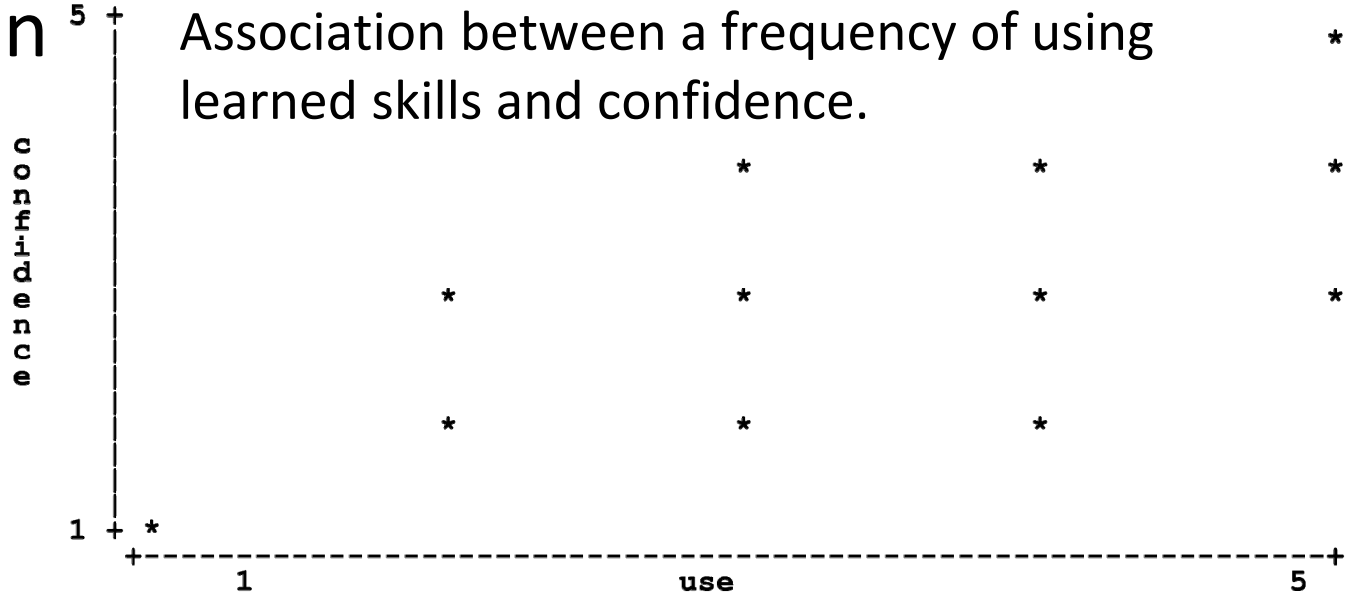
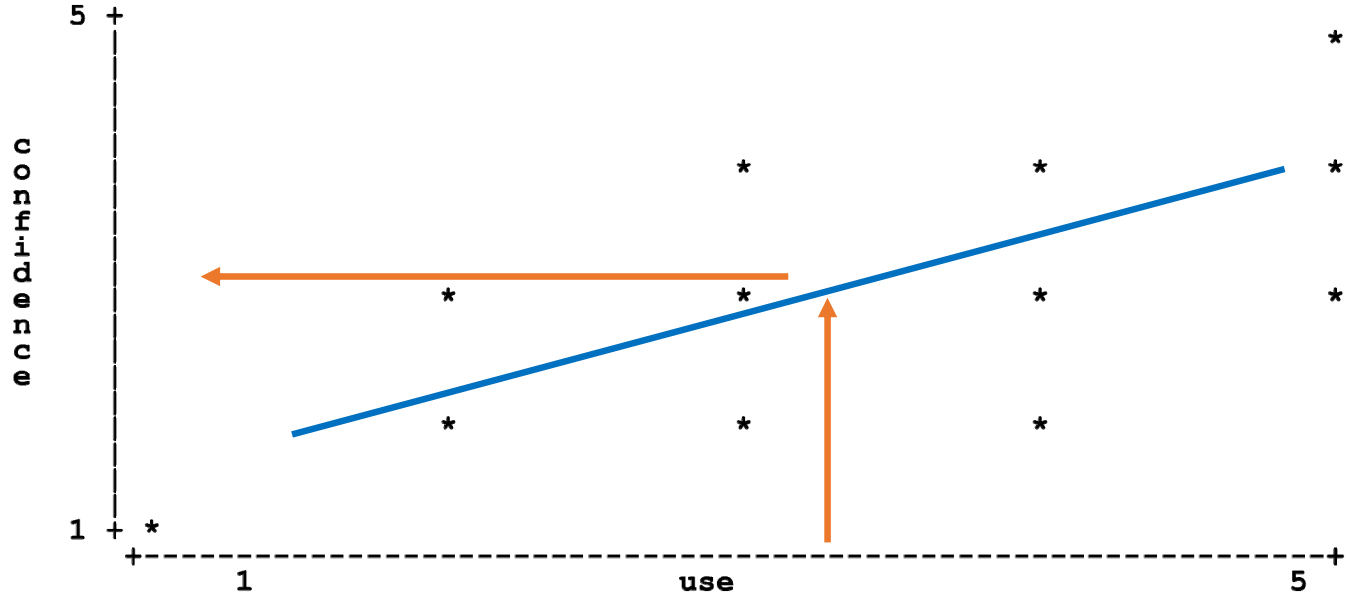
Correlation

Association between a frequency of using learned skills and confidence.



Regression



❖ Parametric

Data type: Continuous

Sample size: Large

Distribution (graph): Bell shape

❖ Non-parametric

Data type: Categorical

Sample size: Small (<30)

Distribution (graph): With outliers

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Group A	Group B
120	105
80	130
90	145
110	125
95	115
Mean ⟺	Mean

t-test

Group A	Group B	Rank A	Rank B
120	105	7	4
80	130	1	9
90	145	2	10
110	125	5	8
95	115	3	6

U-test

Independent

PARA

NON-PARA

Paired

Group A	Group B	A-B
120	105	15
80	130	-50
90	145	-55
110	125	-15
95	115	-20
	0 ⟺	Mean

Paired t-test

Group A	Group B	A-B	Rank A-B
120	105	15	1
80	130	-50	-4
90	145	-55	-5
110	125	-15	-2
95	115	-20	-3

Signed rank-sum test

Tabulation

10 year follow-up study of health behavior and mortality

```
tabulate sm outcome, row chi
```

sm	outcome alive	dead	Total
current smoker	61	85	146
	41.78	58.22	100.00
ex-smoker	74	67	141
	52.48	47.52	100.00
non smoker	268	136	404
	66.34	33.66	100.00
Total	403	288	691
	58.32	41.68	100.00

Pearson chi2(2) = 29.0882 Pr = 0.000

Mortality is significantly different among three groups.

You can not say:

Mortality is significantly higher for current smoker.

Contraceptive Methods	STD +	STD -
Condom		
OC		
IUD		
.		
.		
.		

dep	conf 0	1	Total
0	9	2	11
1	2	2	4
2	0	3	3
Total	11	7	18

Maternal confidence and
Two-item depression score
(0-2; ≥1 = depression tendency)

Simplifying a big table

Categorical data

1. Descriptive analysis only
2. Re-categorize into major categories
3. Re-categorize into one item of interest and others

Continuous data

1. Descriptive analysis only
2. Re-categorize into two by using
   1) a standard cut-off value
   2) mean or median or quantile value

Quick analysis using OpenEpi

http://www.openepi.com

Useful when…

1. You want to calculate 95%CI of a proportion.
2. You have a filled contingency table and want to perform a statistical test.
3. You know mean (SD) of your data and want to perform a statistical test.
4. You want to calculate a sample size.

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Expand All | Collapse

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  - Two by Two Table
  - Dose-Response
  - R by C Table
  - Matched Case Control
  - Screening
- Person Time
  - 1 Rate
  - Compare 2 Rates
- Continuous Variables
  - Mean CI
  - Median/%ile CI
  - t test
  - ANOVA
- Sample Size
  - Proportion
  - Unmatched CC
  - Cohort/RCT
  - Mean Difference
- Power
- Random numbers

OpenEpi Open Source Epidemiologi

Now in English, French, Spanish, Italian, ar

Version 3.03a Updated 2015/05/04 ***Try it in a S***

OpenEpi provid
studies, stratifie
analysis, sample
and other evalua
other useful site

OpenEpi is free
from a web serv
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Test results are
always a good i
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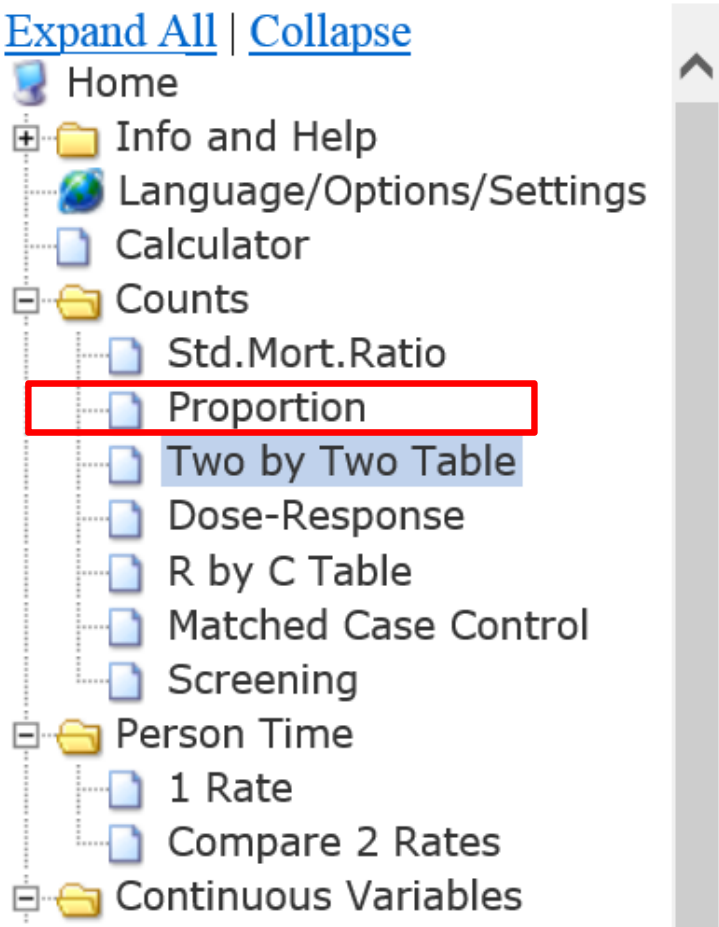
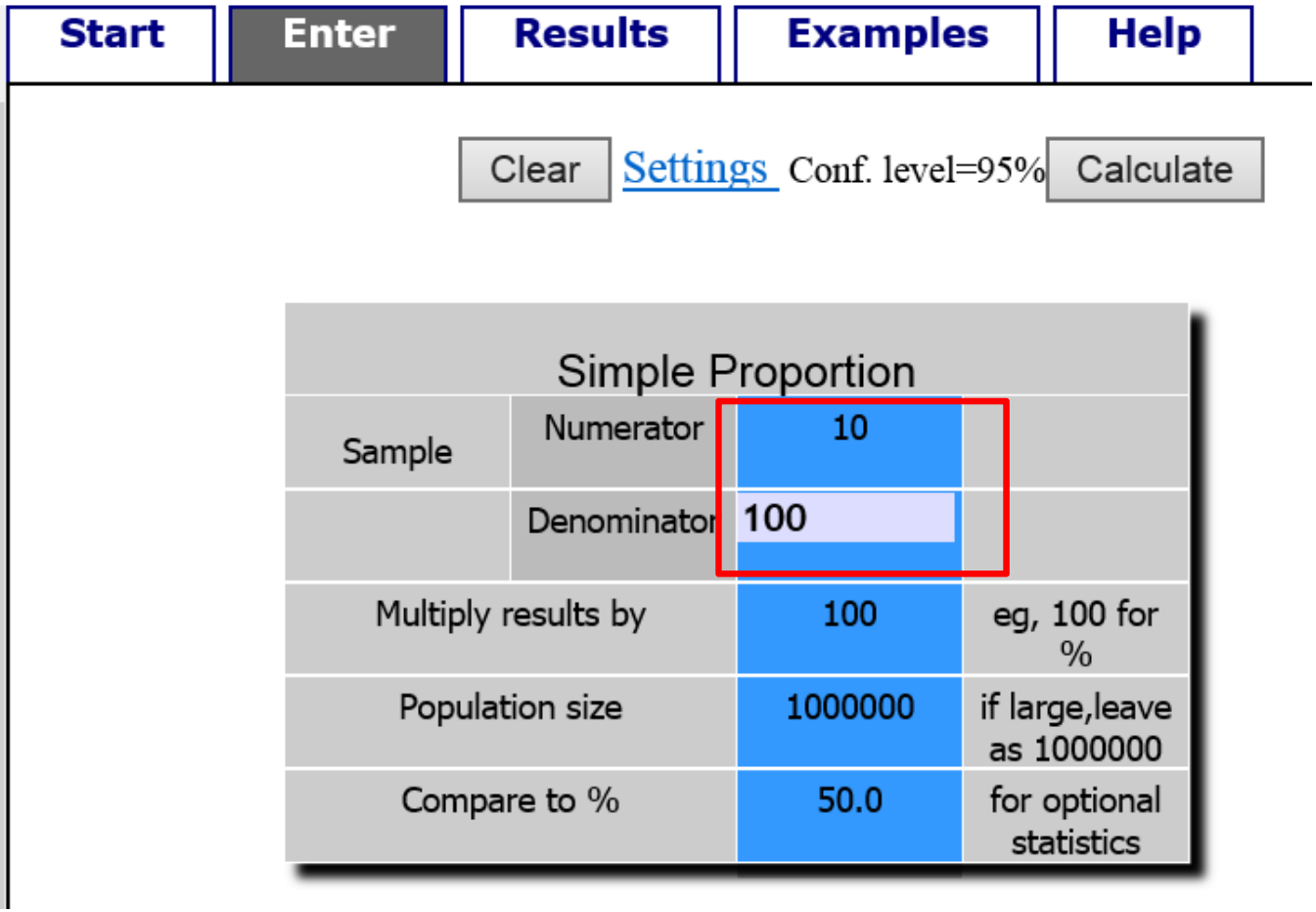
manual at [Info

The programs h
translated. Some of the components from other sources hav

Proportion





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95% Confidence Limits for Proportion 10/100
Multiplier=100
Large population size or sample with replacement.

	Lower CL	Per 100	Upper CL
Proportion as Percent		10	
Mid-P Exact	5.193		17.1
Fisher Exact(Clopper-Pearson)	4.9		17.62
Wald (Normal Approx.)	4.12		15.88
Modified Wald(Agresti-Coull)	5.349		17.61
Score(Wilson)*	5.523		17.44
Score with Continuity Correction (Fleiss Quadratic)	5.163		18.04

*LookFirst items: Editor's choice of items to examine first.

One-Sample Test for Binomial Proportion, Normal-Theory Method
Does proportion 0.1 differ from 0.5?
z-value = -8
Two-sided p-value=<0.0000001

Results from OpenEpi, Version 3, open source calculator--Proportion
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

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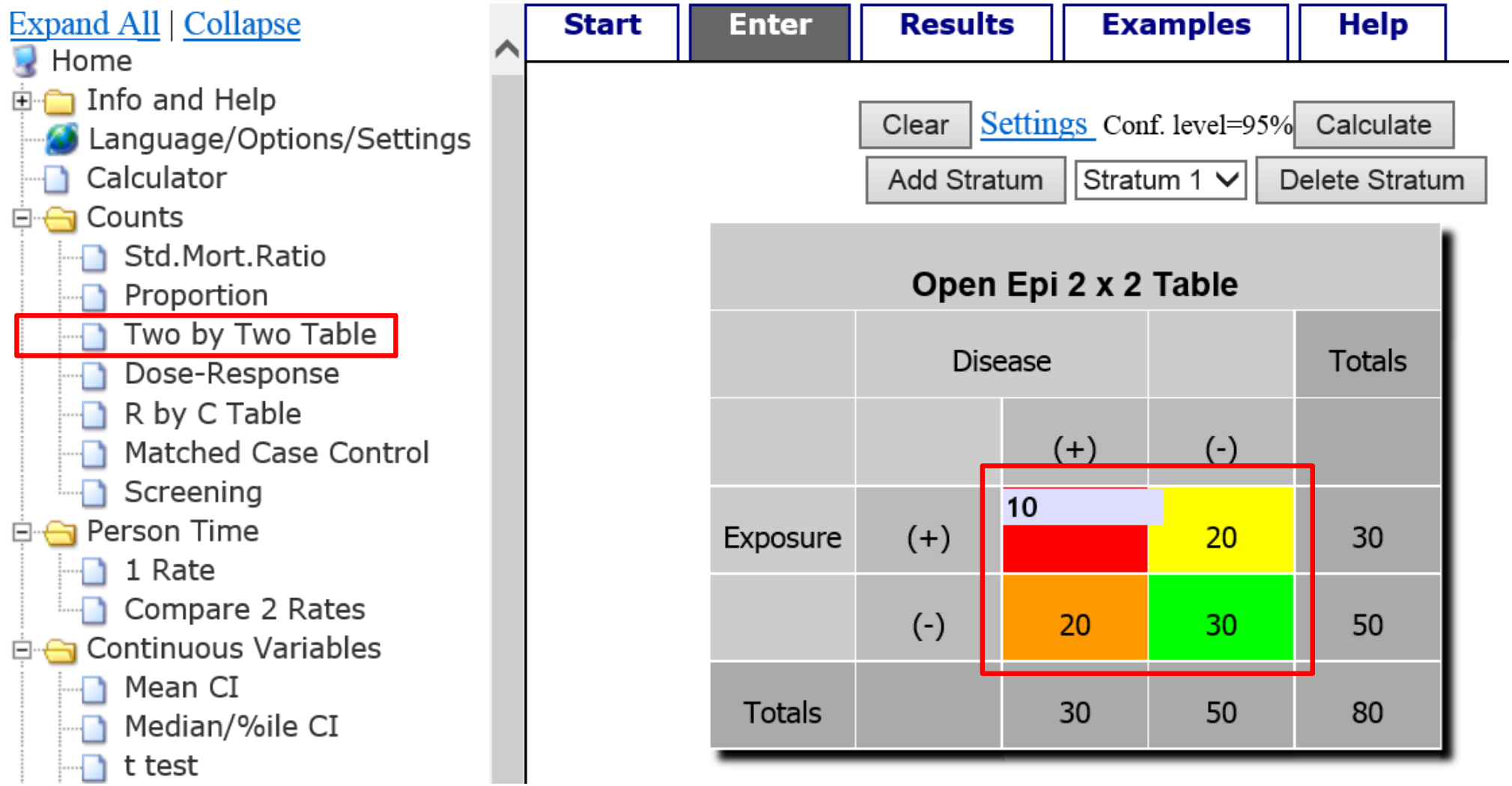
Two by Two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Compare 2 Rates
Continuous Variables
Mean CI
Median/%ile CI
t test
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Clear
Settings
Conf. level=95%
Calculate
Add Stratum
Stratum 1
Delete Stratum
Open Epi 2 x 2 Table
Disease
Totals
(+)
(-)
Exposure
(+)
10
20
30
(-)
20
30
50
Totals
30
50
80

Start | Enter | Results | Examples | Help

2 x 2 Table Statistics

Single Table Analysis

		Disease (+)	Disease (-)
Exposure	(+)	10	2030
	(-)	20	3050
		30	5080

Chi Square and Exact Measures of Association

Test	Value	p-value(1-tail)	p-value(2-tail)
Uncorrected chi square	0.3556	0.2755	0.5510
Yates corrected chi square	0.128	0.3603	0.7205
Mantel-Haenszel chi square	0.3511	0.2767	0.5535
Fisher exact		0.3621(P)	0.7243
Mid-P exact		0.2823(P)	0.5647

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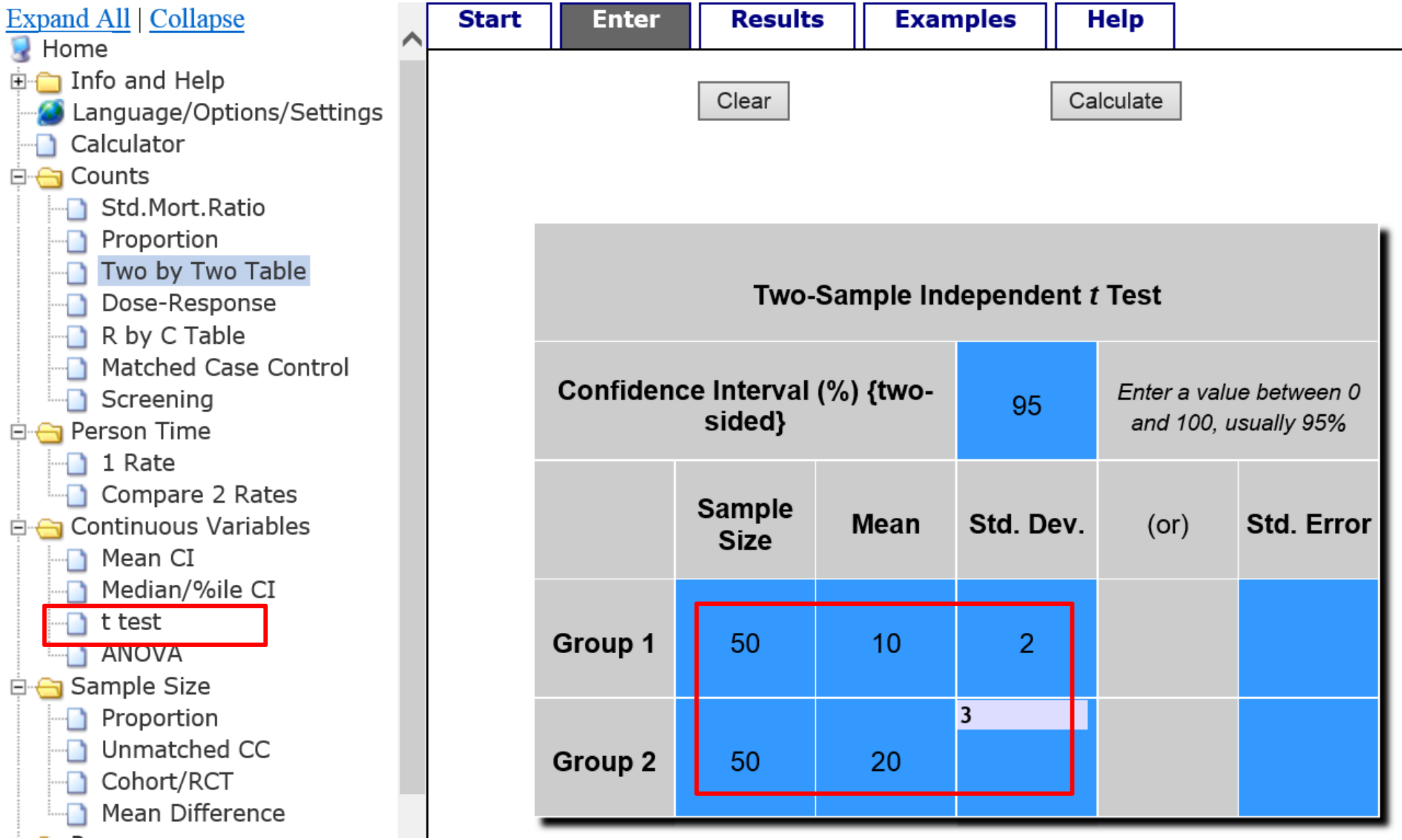
T test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Mean Difference
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Clear
Calculate
Two-Sample Independent t Test
Confidence Interval (%) {two-sided}
95
Enter a value between 0 and 100, usually 95%
Sample Size
Mean
Std. Dev.
(or)
Std. Error
Group 1
50
10
2
Group 2
50
20
3

Start | Enter | Results | Examples | Help

Two-Sample Independent *t* Test

Input Data

Two-sided confidence interval 95%

	Sample size	Mean	Std. Dev.	Std. Error
Group-1	50	10	2	
Group-2	50	12	3	

Result	*t* statistics	*df*	p-value[1]	Mean
Equal variance	-3.92232	98	0.0001628	
Unequal variance	-3.92232	85	0.0001772	

If this p value is 0.05 or higher, select the equal variance p value. If under 0.05, select the unequal variance p value.

	F statistics	*df*(numerator,denominator)	p-value[1]
Test for equality of variance[2]	2.25	49,49	0.005325

[1] p-value (two-tailed)

[2] Hartley's *f* test for equality of variance

Sample size: Cohort/RCT (Comparing %)

- Std.Mort.Ratio
- Proportion
- Two by Two Table
- Dose-Response
- R by C Table
- Matched Case Control
- Screening
- Person Time
  - 1 Rate
  - Compare 2 Rates
- Continuous Variables
  - Mean CI
  - Median/%ile CI
  - t test
  - ANOVA
- Sample Size
  - Proportion
  - Unmatched CC
  - Cohort/RCT
  - Mean Difference

Start | Enter | Results | Examples | Help

Clear | Calculate

Sample Size:X-Sectional, Cohort, & Randomized Clinical Trials

Two-sided confidence level(%)	95	(1-alpha) usually 95%
Power (1-beta or % chance of detecting)	80	Usually 80%
Ratio of Unexposed to Exposed in sample	1.0	For equal samples, use 1.0
Percent of Unexposed with Outcome	5	Between 0.0 and 99.9
Please fill in 1 of the following. The others will be calculated.		
Odds ratio		
Percent of Exposed with Outcome	10	Between 0.0 and 99.9
Risk/Prevalence Ratio		
Risk/Prevalence difference		Between -99.99 and 99.99

Start | Enter | Results | Examples | Help

Sample Size:X-Sectional, Cohort, & Randomized Clinical Trials

Two-sided significance level(1-alpha):	95
Power(1-beta, % chance of detecting):	80
Ratio of sample size, Unexposed/Exposed:	1
Percent of Unexposed with Outcome:	5
Percent of Exposed with Outcome:	10
Odds Ratio:	2.1
Risk/Prevalence Ratio:	2
Risk/Prevalence difference:	5

	Kelsey	Fleiss	Fleiss with CC
Sample Size - Exposed	437	436	475
Sample Size-Nonexposed	437	436	475
Total sample size:	874	872	950

Sample size: Mean Difference

- Counts
  - Std.Mort.Ratio
  - Proportion
  - Two by Two Table
  - Dose-Response
  - R by C Table
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  - ANOVA
- Sample Size
  - Proportion
  - Unmatched CC
  - Cohort/RCT
  - Mean Difference

Start | Enter | Results | Examples | Help

Clear | Calculate

Sample Size For Comparing Two Means

Confidence Interval % (two-sided)			95	*Enter a value between 0 and 100, usually 95%*
Power			80	*Enter a value between 0 and 100, usually 80%*
Ratio of sample size (Group 2/Group 1)			1	
	Group 1		**Group 2**	Enter means OR difference on next line
Mean	10	and	12	**or Difference**
Std. Dev.	3		4	*Enter Std. Deviation OR Variance of each group*
Variance				

Start | Enter | Results | Examples | Help

Sample Size For Comparing Two Means

Input Data

Confidence Interval (2-sided)	95%
Power	80%
Ratio of sample size (Group 2/Group 1)	1

	Group 1	Group 2	Difference*
Mean	10	12	-2
Standard deviation	3	4	
Variance	9	16	

Sample size of Group 1	50
Sample size of Group 2	50
Total sample size	100

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Exercise data

	Mean (SD) or N(%)		
	City A N=200	City B N=200	p-value*
Systolic blood pressure	123 (20)	120 (25)	
Hypertension			
Yes	20 (10%)	12 (6%)	
No	180 (90%)	188 (94%)	

* T-test or Chi-square test was used.

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Assignments

1. Calculate 95% confidence interval of a prevalence of hypertension in each city. “**Proportion**”
2. Select and perform an appropriate statistical test for each item (BP and HT). “**Two by Two**” or “**t test**”
3. The sample data is from a pilot test. Calculate a sample size for the main survey. “**Cohort/RCT**” or “**Mean Difference**”
4. Try ADVANCE exercise

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Hypothesis testing

Is new Drug A more effective than Drug B?

→ Is there a difference in the effect of Drug A and Drug B?

→ **P**robability that the null hypothesis (effect of A = effect of B) is true

You check the difference by rejecting ($p<0.05$) the hypothesis that two are the same.

NOTE. Even if p value is higher than 0.05, it does not mean that the null hypothesis is true. P is just a probability.

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❖Simple understanding

You don’t want to make a mistake by saying that the new drug is effective when it is not.

You want to make the probability of the mistake to be small.

Low p value means less chance of making the mistake and you are more confident that there is a real difference.

	Truth - Different	Truth - Same
Survey result Different		P value
Survey result Not different		

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❖ ADVANCED statistical understanding

	Truth Null hypothesis is NOT true	Truth Null hypothesis is true
Reject the null hypothesis	 Power	Type I error False positive Alpha P value
NOT reject the null hypothesis	Type II error False negative Beta	

IAEA - Hiroshima University Consultancy Meeting

Science, Technology and Society Perspectives on Nuclear Science, Radiation and Human Health – The International Perspective

Health literacy promotion in Fukushima after the nuclear accident:

A case of responding to health care professionals' needs through the development of a health literacy toolkit

Aya Goto

Center for Integrated Science and Humanities

Fukushima Medical University

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Fukushima nuclear accident

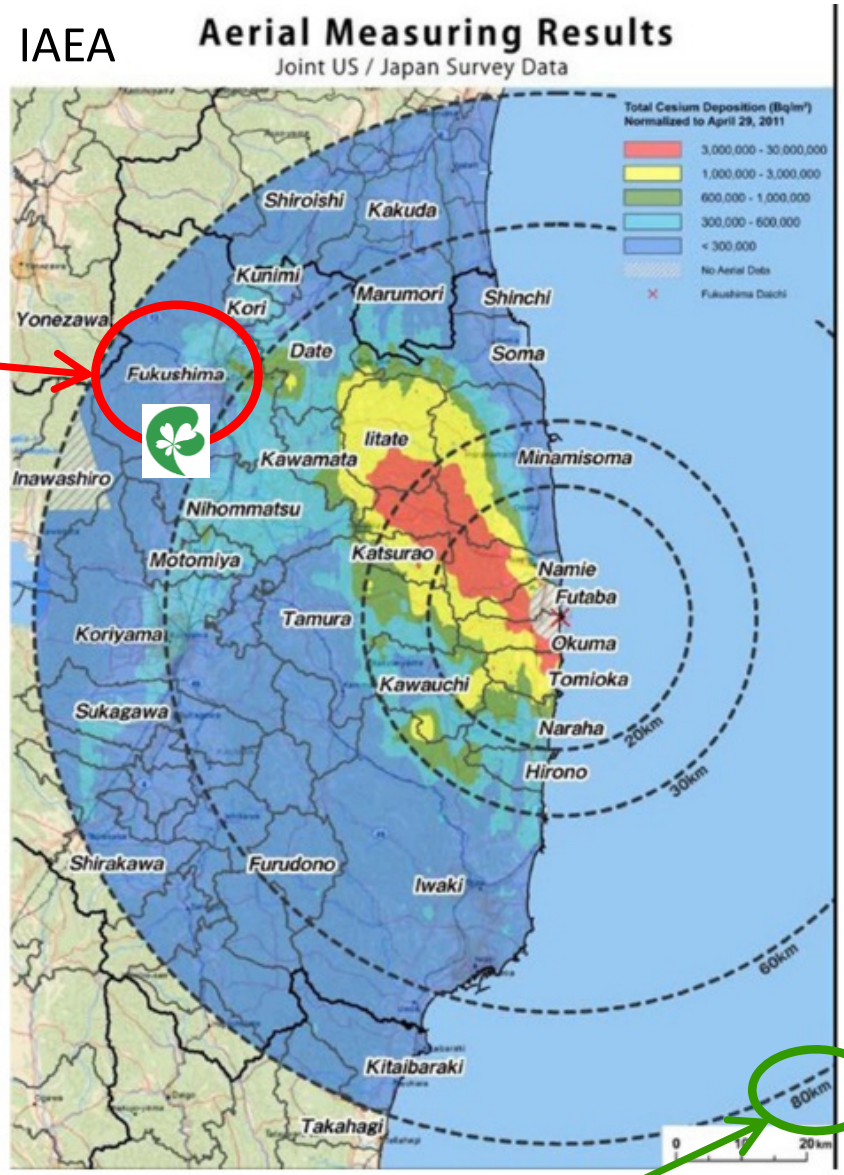
Fukushima City

15% decline in under 5-yo pop. in 2 years

Depression and decline in maternal confidence among Fukushima mothers

BMC Psychiatry. 2015; 15: 59.

J Commun Healthc. 2014; 7: 106-116.



50 miles: US Recommended Evacuation Zone

Fear of unknown health effects of radiation contamination due to confusing and often contradicting health risk messages with difficult scientific data

Picture: Leaflets about radiation placed in the lobby of a health center in Fukushima City.

Community health workers

Government

Fukushima Nuclear Accident Independent Investigation Commission

"Information for residents to make informed decisions"

How do we respond to parents' concerns ?

Public health nurses

(gate keepers of community health)

Nursery school teachers

(key players of maternal and child health)

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Health literacy

- “The cognitive and social skills which determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health” WHO, 1998

http://www.hsph.harvard.edu/healthliteracy/overview/

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Health literacy training

Table 2 Content of the health literacy training program in Fukushima City

First session	Second session	Follow-up survey
1. Ice-breaking activity 2. Lecture • General background of health literacy • Instructions to use material assessment tools 3. Exercise • Assessment of an assigned written health material 4. Training evaluation 5. Homework • Assessment of materials that participants themselves developed	1. Review quiz 2. Lecture Techniques to improve; • Text • Graphics • Risk presentation 3. Exercise • Revision of their own materials that they had assessed as homework 4. Training evaluation 5. Homework • Apply learned knowledge and skills in practice	1. Review of one-month application 2. Training evaluation 3. Distribute additional information leaflet about tips to apply health literacy in practice

- Goto A, et al. Japan Medical Association Journal. 2014; 57: 146-53.
- Rudd RE. Assessing health materials: Eliminating barriers – increasing access. 2010. http://www.hsph.harvard.edu/healthliteracy/

Training content

- Sentences: Grade level, topic sentence
- Numbers: Numeracy level

  RISK is one of the most difficult statistical concepts.

  (Apter AJ, et al. J Gen Intern Med. 2008;23(12):2117-24.)

- Graphs: Pictogram

- Communication: Marker method

(Method to ask readers to mark difficult words and phrases.)

Training evaluation

- Workshop evaluation surveys among participants
- 65 nurses and 45 teachers who attended workshops in 2013-2014
- At the end of each session, 1 month (nurses only) and 1 year after the second session.
- Evaluation items
  - Application, confidence gain and interest in further training.
  - 12 specific training goals: 4 items each on knowledge, material assessment and development
  - Opinions on applications and barriers of learned skills in daily practices

Japan Medical Association Journal. 2015; 58: 1-9.
Journal of Seizon and Life Sciences. 2017; 27: 192-207.

Achievements toward training objectives

	TOTAL (N=57)	Nurses (N=31)	Teachers (N=26)
I applied learned skills in practice.	61%	68%	47%
I gained confidence in assessing in revising written materials.	27%	32%	20%
I want to attend further training.	68%	81%	54%
Selected knowledge items			
I can explain health literacy needs.	42%	65%	15%
I can explain numeracy levels.	9%	12%	4%
Selected assessment items			
I can use the Marker Method	47%	61%	29%
Selected development items			
I can write easy-to-read text.	44%	52%	35%
I can explain risk.	14%	16%	12%

Application and confidence

Nurses and teachers	Non-users (N=22)	Users (N=35)	P value
I gained confidence in assessing and revising written materials	32%	45%	( )
I want to attend further training.	41%	86%	( )

A five-ping Likert-scale ranging from highly disagree (1) to highly agree (5) was used. Those who answered 4 and 5 to the item “I applied learned skills in practice” was classified as users. Chi-square test was used.

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Assignments

1. First table: Interpret the results
2. Second table: Calculate p values and interpret the results

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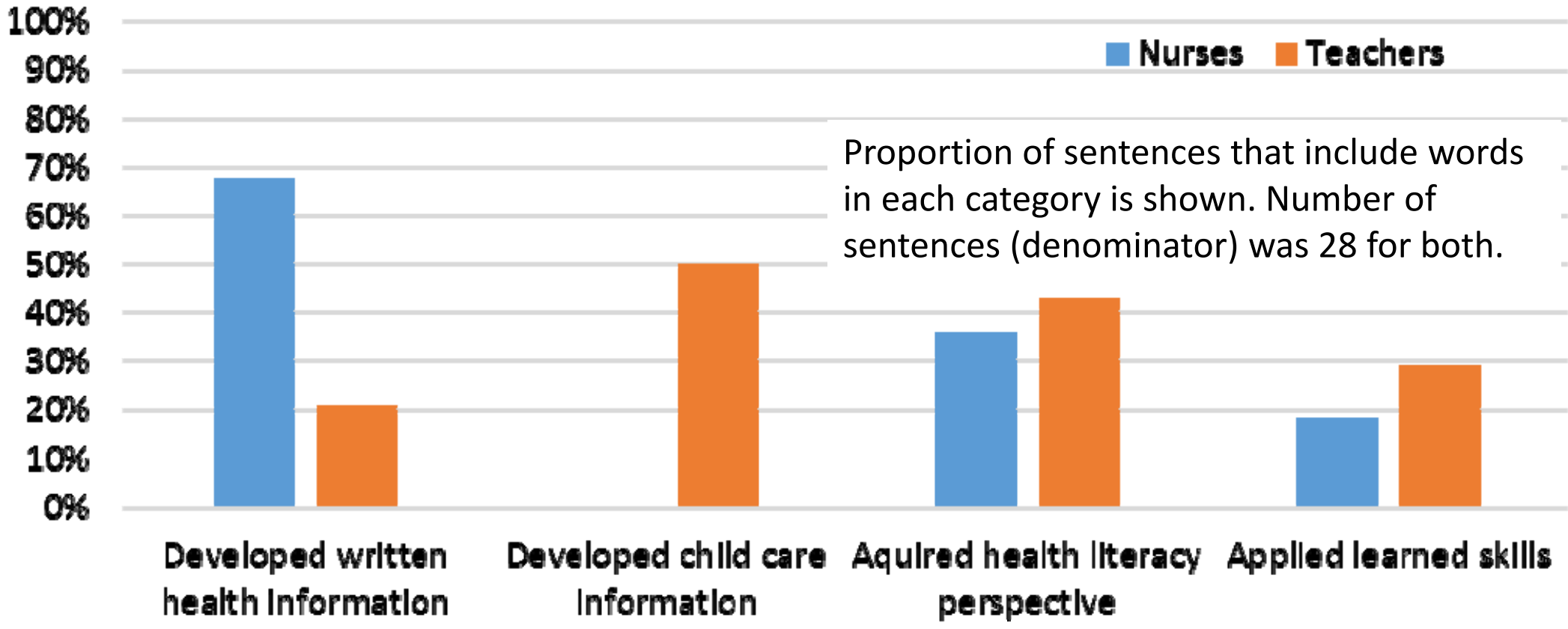
Applications during the follow-up



"Even among staff, we started circulating documents and getting signatures in addition to oral communication." (Nursery school teacher)

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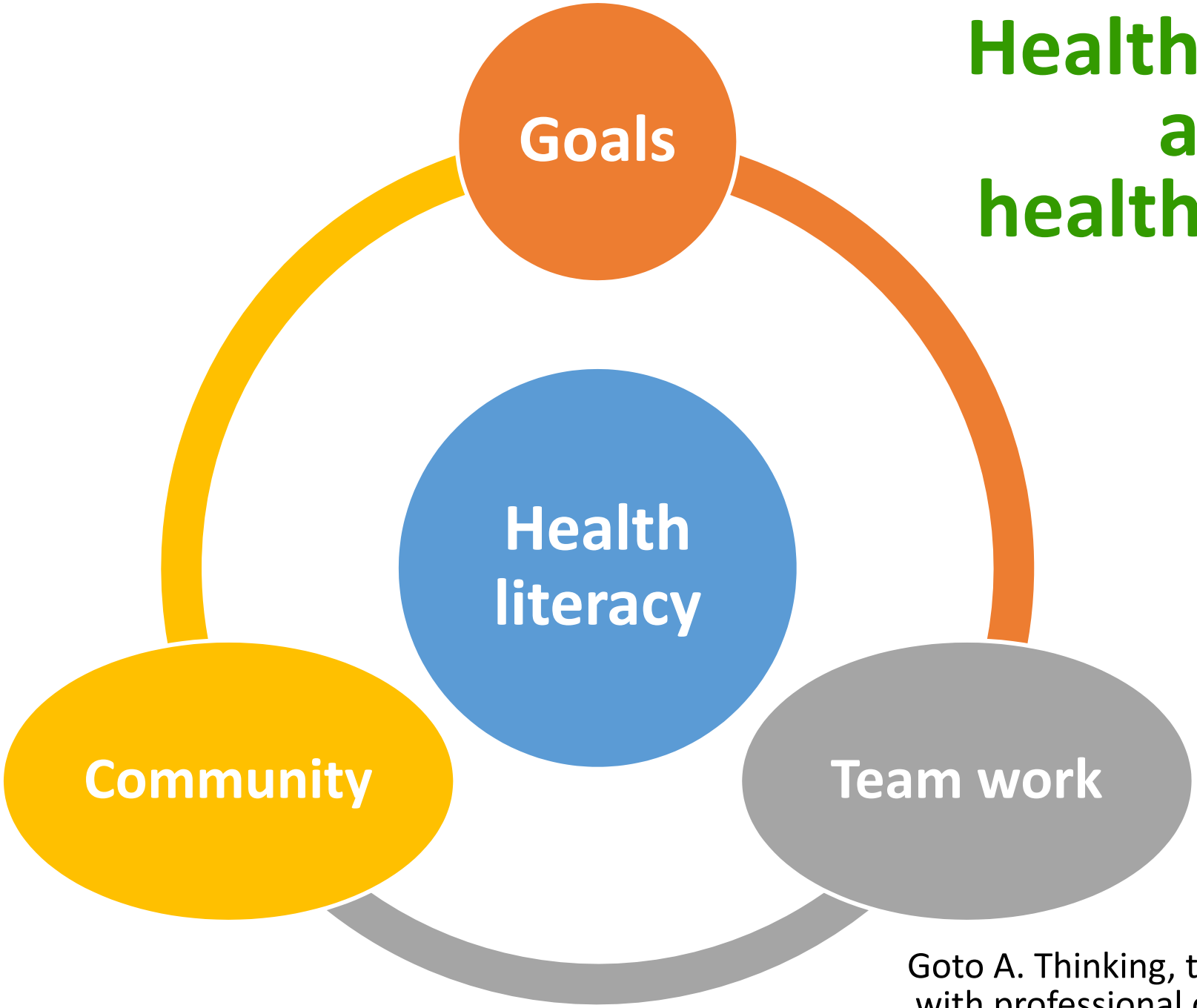
Health literacy and health system



Annals of the ICRP
Goto A. Thinking, talking, and working with professional community workers after the Fukushima nuclear accident.