

22S:30/105
Statistical Methods and
Computing

Introduction to Types of Studies

Lecture 7
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Koch's postulates

- In 1890 the German microbiologist Robert Koch attempted to develop criteria for establishing whether a particular micro-organism *causes* a particular disease
- not considered completely satisfactory today
- "... first, the organism is always found with the disease, in accord with the lesions and clinical stage observed; second, the organism is not found with any other disease; third, the organism, isolated from one who has the disease and cultured through several generations, reproduces the disease in a susceptible experimental animal. Even where an infectious disease cannot be transmitted to animals, the 'regular' and 'exclusive' presence of the organism proves a causal relationship."

Experiments and observational studies

- In an *experiment*, the investigator studies the effect of varying some factor that he/she controls.
- In an *observational study*, the investigator merely observes and records information on the subjects but does not manipulate any factors.
- It is very difficult to establish *causation* between one variable and another.
 - especially difficult based on observational studies

More formal criteria for judging whether an observed association is causal

- strength of the association
- dose-response relationship
- consistency of the association
 - Is the association observed in one study observed in other study populations, in studies using different methods, etc.
- temporally correct association
- specificity of the association
 - the alleged effect is rarely if ever observed without the alleged cause
- plausibility

Example: Female literacy and infant mortality

The SAS System 1
09:41 Friday, February 15, 2013

Obs	infmort	femlit	country
1	19	96	Argentin
2	75	66	Bolivia
3	83	36	Brazil
4	11	95	Chile
5	25	90	Columbia
6	14	95	Costa
7	7	96	Cuba
8	43	81	Dominica
9	30	87	Ecuador
10	30	73	El
11	41	58	Guatemal
12	58	97	Guyana
13	91	41	Haiti
14	33	69	Honduras
15	10	89	Jamaica
16	28	87	Mexico
17	39	67	Nicaragu
18	18	90	Panama
19	27	90	Paraguay
20	43	83	Peru
21	28	91	Suriname
22	16	97	TrinToba
23	16	98	Uruguay
24	21	90	Venezuel

The CORR Procedure
2 Variables: infmort femlit

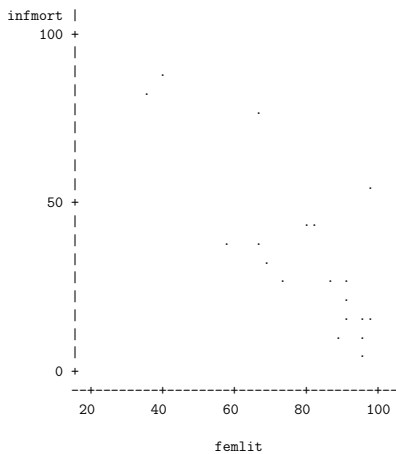
Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
infmort	24	33.58333	22.75181	806.00000	7.00000	91.00000
femlit	24	81.75000	17.41626	1962	36.00000	98.00000

Pearson Correlation Coefficients, N = 24
Prob > |r| under H0: Rho=0

	infmort	femlit
infmort	1.00000	-0.81421 <.0001
femlit	-0.81421 <.0001	1.00000

Plot of infmort*femlit. Symbol used is '.'



NOTE: 5 obs hidden.

Association does not by itself imply causation.

Confounding

Two variables (explanatory or lurking) are **confounded** when their effects on a response variable cannot be separated.

- How a sample is drawn from a population affects how valid it is to apply conclusions based on the sample to the population.
- The **sample design** is the method used to choose the sample from the population.

Populations and samples

- A **population** is the *entire set* of items about which we might wish to draw conclusions.
 - Example: I wish to find out the average income of families of current UI undergrads.
 - Example: A political pollster would like to know the Presidential preference of every registered voter in South Carolina.
 - Some populations we would like to study are hypothetical.
 - * Example: all pregnant women who are infected with the HIV virus now and in the future
- A **sample** is the subset of the population that we can actually study (on which we can measure values of variables).

Bias

- The results of a study are **biased** if they are subject to systematic error.
 - i.e., there is something about the way the study is carried out such that, if we did many studies in this way, on average we'd get the wrong conclusions!
- One source of bias is if the sample is not *representative* of the entire population.
- The design of a study is **biased** if it systematically favors certain outcomes.

Kinds of sample designs

- simple random sample (SRS)
 - a sample of size n individuals chosen in such a way that every set of n individuals in the population has an equal chance to be the sample
 - the ideal
 - biased or unbiased?
- voluntary response sample
 - consists of people who choose themselves by responding to a general appeal
 - biased or unbiased?
- convenience sample
 - consists of subjects who are easy to get
 - biased or unbiased?

How simple random samples are drawn

- each member of the population is uniquely identified in some way
 - example: the population of interest is UI students; each has a unique ID number
- intuitive idea: the identifiers are put in a hat and drawn at random
- usually actually done by a computer
- can be done manually using a table of random digits
 - first assign a unique numeric label to each member of the population
 - use table of digits to select labels at random.

- judgment sample
 - consists of subjects chosen by an expert to be representative of the population
 - biased or unbiased?

Example

- I wish to get an idea as to how well undergrad students in 22S:30 like the textbook. To do this, I want to administer a lengthy interview and I have time to do only 3. Therefore, I want to draw a simple random sample of size 3 from the population of 24 undergrad students in the class.

- Begin by giving each student a unique numeric identifier.
 1. Derek A
 2. Kara
 3. Courtney
 4. Karen
 5. Cory
 6. Catherine
 7. Katie H
 8. Ryan
 9. Jenna
 10. Peter
 11. Anne
 12. Todd
 13. Anthony
 14. Katie McE
 15. Kimbra
 16. Phil

Table of random digits

- Each entry in the table is equally likely to be any of the 10 digits from 0 to 9 inclusive.
- The entries are “independent” of each other; i.e., knowledge of what digits are in one part of the table gives no information about the digits in any other part.

17. Derek N
18. Tuyet
19. Ben
20. Mitchell
21. Nicole
22. Cristina
23. Joanna
24. Jessica

- Use Table B in your book to find the first 3 of these identifiers that appear.

Using SAS to draw a simple random sample

```
options linesize = 79 ;

data students ;
input name $9. ;
datalines ;
Derek A
Kara
Courtney
Karen
Cory
Catherine
Katie H
Ryan
Jenna
Peter
Anne
Todd
Anthony
Katie McE
Kimbra
Phil
Derek N
```

```

Tuyet
Ben
Mitchell
Nicole
Cristina
Joanna
Jessica
;

proc print data = students ;
run ;

```

Output

Obs	Name
1	Derek A
2	Kara
3	Courtney
4	Karen
5	Cory
6	Catherine
7	Katie H
8	Ryan
9	Jenna
10	Peter
11	Anne
12	Todd
13	Anthony
14	Katie McE
15	Kimbra
16	Phil
17	Derek N
18	Tuyet
19	Ben
20	Mitchell
21	Nicole

```

22 Cristina
23 Joanna
24 Jessica

```

Proc plan

```

proc plan seed = 72950 ;
factors a = 3 of 24 ;
run ;

```

The PLAN Procedure

Factor	Select	Levels	Order
a	3	24	Random

----a----

1 24 7

Using the same seed will reproduce exactly the same “random” choice!

```
proc plan seed = 72950 ;
factors a = 3 of 24 ;
run ;
```

The PLAN Procedure

Factor	Select	Levels	Order
a	3	24	Random

-----a-----

1 24 7

Using a different seed will produce a different set of choices.

```
proc plan seed = 32542 ;
factors a = 3 of 24 ;
run ;
```

Procedure PLAN

Factor	Select	Levels	Order
a	3	24	Random

-----a-----

2 16 4

Drawing from a larger population

```
proc plan seed = 241 ;
factors a = 100 of 1000 ;
run ;
```

Procedure PLAN

Factor	Select	Levels	Order
a	100	1000	Random

a

```
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
576 792 359 517 110 598 859 144 9 52 462 262 673 202 648
630 705 286 412 597 868 488 621 240 674 651 923 298 419 865
550 120 441 921 139 644 269 861 775 529 168 939 50 281 57
119 944 692 265 432 470 311 585 69 329 143 562 974 996 904
901 767 507 819 844 518 264 822 897 271 820 239 435 341 442
497 773 687 449 41 424 24 326 863 178 752 423 233 834 358
864 481 362 584 28 479 594 235 337 175
```

Other statistical sampling designs

- Statistical sampling is based on *chance*.
- A **probability sample** gives each member of the population of interest a *known* chance of being selected.
- **stratified random sampling**
 - procedure
 - * first divide the population into *strata*
 - groups of similar individuals
 - * draw a simple random sample from each stratum
 - * combine the SRSs to form the full sample
 - ensures that each stratum is represented in the overall sample

- Example: survey of class opinions on the textbook
 - * I might divide the class into men and women and take a SRS within each gender
- Probability sampling methods other than SRSs require more complicated statistical analysis than do SRSs.
 - But meaningful results **can** be obtained because we know what population was actually sampled and exactly how it was done.
 - This contrasts with voluntary response samples, convenience samples, and judgment samples.

- Nonresponse
 - Some members of the chosen sample cannot be contacted or refuse to answer.
 - This biases the results of the survey if the members who do not respond are different from the general population.
 - Example: in surveys that include questions about household income, families with unusually low or unusually high incomes are less likely to answer that question than are families with moderate income.

Other possible sources of bias in surveys

- Undercoverage
 - The list of individual items from which a sample is chosen is called the *sampling frame*
 - Some segments of the population of interest are likely to be missed even with careful sampling methods because they are not included in the sampling frame
 - * Example: telephone surveys systematically miss the 6% of American households without phones.

- Response bias
 - Respondents may lie, especially about sensitive subjects.
 - Attributes or behavior of interviewers can make this more likely.

– Example: In a survey concerning roles of family members, a father might tend to respond differently to the question

“How many hours per week do you spend caring for your children on average?”

depending on the gender of the interviewer.

- Bias due to wording of questions
 - leading questions
 - confusing questions
 - questions involving undefined terms
 - Example: Do you eat 5 servings of fruits and vegetables per day?