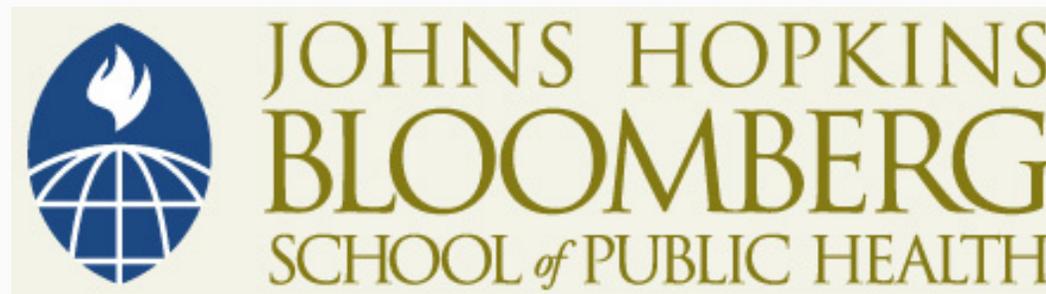


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JOHNS HOPKINS  
BLOOMBERG  
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## Section C

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Estimating Confidence Intervals for the Mean of a Population Based on a Single Sample of Size  $n$ : Some Examples

# Estimating a 95% Confidence Interval

- In last section we defined a 95% confidence interval for the population mean  $\mu$

- Interval given by  $\bar{x} \pm 2SE(\bar{x}) : \bar{x} \pm 2 * \frac{\sigma}{\sqrt{n}}$

- Problem: we don't know  $\sigma$  either

- Can estimate with  $s$ , such that our estimated SE is

- $SE(\hat{\bar{x}}) = \frac{s}{\sqrt{n}}$

- Estimated 95% CI for  $\mu$  based on a single sample of size  $n$

- $\bar{x} \pm 2 * \frac{s}{\sqrt{n}}$

## Example 1

- Suppose we had blood pressure measurements collected from a random sample of 100 Hopkins students collected in September 2008
- We wish to use the results of the sample to estimate a 95% CI for the mean blood pressure of all Hopkins students
- Results:
  - $\bar{x} = 123.4$  mmHg;  $s = 13.7$  mmHg
  - $SE(\bar{x}) = \frac{13.7}{\sqrt{100}} = 1.37$  mmHg
- So a 95% CI for the true mean BP of all Hopkins Students:
  - $123.4 \pm 2 \times 1.37 \rightarrow 123.4 \pm 2.74$
  - $\rightarrow (120.66 \text{ mmHg}, 126.14 \text{ mmHg})$

## Example 2

- Data from the National Medical Expenditures Survey (1987):
  - U.S. Based Survey Administered by the Centers for Disease Control (CDC)
- Some results:

	Smoking History	No Smoking History
Mean 1987 Expenditures (U.S. \$)	2,260	2,080
SD (U.S. \$)	4,850	4,600
N	6,564	5,016

## Example 2

- 95% CIs for 1987 medical expenditures by smoking history

- Smoking history:  $2,260 \pm 2 \times \frac{4,850}{\sqrt{6,564}} \rightarrow 2,260 \pm 120 \rightarrow (\$2,140, \$2,380)$

- No smoking history:  $2,080 \pm 2 \times \frac{4,600}{\sqrt{5,016}} \rightarrow 2,080 \pm 130 \rightarrow (\$1,950, \$2,210)$

## Example 3

- Effect of lower targets for blood pressure and LDL cholesterol on atherosclerosis in diabetes: the SANDS Randomized Trial<sup>1</sup>
  - “**Objective:** To compare progression of subclinical atherosclerosis in adults with type 2 diabetes treated to reach aggressive targets of low-density lipoprotein cholesterol (LDL-C) of 70 mg/dL or lower and systolic blood pressure (SBP) of 115 mm Hg or lower vs standard targets of LDL-C of 100 mg/dL or lower and SBP of 130 mm Hg or lower.”

## Example 3

- **“Design, setting, and participants:** a randomized, open-label, blinded-to-end point, three-year trial from April 2003-July 2007 at four clinical centers in Oklahoma, Arizona, and South Dakota. Participants were 499 American Indian men and women aged 40 years or older with type 2 diabetes and no prior CVD events.”
- **“Interventions:** participants were randomized to aggressive (n = 252) vs. standard (n = 247) treatment groups with stepped treatment algorithms defined for both.”

## Example 3

- **Results mean:** target LDL-C and SBP levels for both groups were reached and maintained
  - Mean (95% confidence interval) levels for LDL-C in the last 12 months were **72 (69-75)** and **104 (101-106)** mg/dL and SBP levels were **117 (115-118)** and **129 (128-130) mmHg** in the aggressive vs. standard groups, respectively

# Example 3

- Lots of 95% CIs!

**Table 2.** Differences in Mean Changes From Baseline to 36 Months, Aggressive vs Standard Groups<sup>a</sup>

	Mean (95% Confidence Interval)							P Value for Difference
	Baseline		36 mo <sup>b</sup>		Change at 36 mo			
	Aggressive	Standard	Aggressive	Standard	Aggressive	Standard	Difference	
Weight, kg	90 (88 to 93)	90 (88 to 92)	91 (89 to 94)	91 (88 to 93)	1.0 (-0.8 to 2.2)	1.0 (-0.3 to 2.3)	0.3 (-1.7 to 2.3)	.83
BMI <sup>c</sup>	34 (33 to 34)	33 (32 to 34)	34 (33 to 35)	34 (33 to 34.4)	0.3 (-0.3 to 0.9)	0.4 (-0.1 to 0.9)	0.1 (-0.6 to 0.9)	.77
Waist, cm	110 (108 to 112)	110 (108 to 112)	111 (109 to 113)	110 (108 to 112)	0.2 (-1.0 to 1.6)	0.6 (-0.7 to 2.0)	0.4 (-1.5 to 2.3)	.66
CRP mg/L <sup>d</sup>	2.7 (2.3 to 3.1)	2.8 (2.4 to 3.3)	2.2 (1.9 to 2.7)	3.3 (2.8 to 3.8)	-0.7 (11) <sup>e</sup>	0.9 (9) <sup>e</sup>	1.6 (-0.4 to 3.6) <sup>e</sup>	.12 <sup>e</sup>
DBP, mm Hg	74 (73 to 76)	76 (75 to 78)	67 (66 to 68)	73 (72 to 74)	-7 (-8 to -6)	-3 (-4 to -1)	4.0 (2.5 to 5.5) <sup>f</sup>	<.001
SBP, mm Hg	128 (126 to 130) <sup>g</sup>	133 (131 to 135) <sup>g</sup>	117 (115 to 118)	129 (128 to 130)	-11 (-13 to -9)	-3 (-5 to -1)	8 (6 to 12) <sup>f</sup>	<.001
Glucose, mg/dL	159 (151 to 168)	156 (147 to 166)	169 (158 to 179)	169 (158 to 180)	11 (1 to 23)	14 (1 to 28)	4 (-14 to 22)	.68
HDL-C, mg/dL	46 (44 to 48)	46 (44 to 47)	48 (47 to 50)	48 (47 to 50)	3.0 (1.4 to 3.8)	3.0 (1.2 to 3.9)	0.1 (-1.9 to 1.8)	.94
LDL-C, mg/dL	104 (100 to 108)	104 (100 to 108)	72 (69 to 75)	104 (101 to 106)	-31 (-35 to -26)	1 (-3 to 6)	32 (26 to 38) <sup>f</sup>	<.001
Non-HDL-C, mg/dL	138 (134 to 142)	140 (136 to 144)	102 (98 to 106)	138 (135 to 141)	-35 (-40 to -30)	0.2 (-4.4 to 4.9)	35 (28 to -42) <sup>f</sup>	<.001
TC, mg/dL	184 (180 to 188)	185 (181 to 190)	150 (146 to 154)	187 (183 to 190)	-32 (-37 to -27)	3 (-2 to 8)	35 (27 to 42) <sup>f</sup>	<.001
TC/HDL-C, mg/dL	4.2 (4.1 to 4.4)	4.2 (4.1 to 4.4)	3.3 (3.1 to 3.4)	4.0 (3.9 to 4.2)	-1.0 (-1.1 to -0.8)	-0.1 (-0.3 to 0.0)	0.8 (0.6 to 1.0) <sup>f</sup>	<.001
Triglycerides, mg/dL <sup>d</sup>	158 (149 to 167)	168 (159 to 177)	137 (130 to 144)	160 (153 to 168)	-26 (78) <sup>e</sup>	-12 (84) <sup>e</sup>	14 (-3 to 29) <sup>ef</sup>	.06 <sup>e</sup>
Hemoglobin A <sub>1c</sub>	8.2 (7.9 to 8.4)	7.9 (7.6 to 8.1)	8.3 (8.0 to 8.6)	8.2 (7.8 to 8.5)	0.1 (-0.2 to 0.4)	0.3 (-0.1 to 0.6)	0.2 (-0.3 to 0.6)	.45

Abbreviations: BMI, body mass index; CRP, C-reactive protein; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol.

SI conversions: for CRP to nmol/L, multiply by 9.524; for glucose to mmol/L, multiply by 0.0555; for HDL-C, LDL-C, and TC to mmol/L multiply by 0.0259; for hemoglobin A<sub>1c</sub> to proportion of total hemoglobin, multiply by 0.01; and for triglycerides to mmol/L, multiply by 0.0113.

<sup>a</sup>Twenty-three baseline variables are compared and presented in Tables 1 and 2.

<sup>b</sup>N for the 36-mo lipids variables was 458 and the mean values were based on the average of 24-, 30- and 36-month observations.

<sup>c</sup>BMI is calculated as weight in kilograms divided by height in meters squared.

<sup>d</sup>Geometric mean (95% confidence interval).

<sup>e</sup>P value is based on arithmetic mean.

<sup>f</sup>Significant mean difference at 36 mo: DBP, LDL-C, non-HDL-C, SBP, TC, TC/LDL-C, and triglycerides (*P* < .001).

<sup>g</sup>Significant differences at baseline for SBP, *P* = .003.

# Example 3

- Lots of 95% CIs!

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<sup>f</sup>Significant mean difference at 36 mo: DBP, LDL-C, non-HDL-C, SBP, TC, TC/LDL-C, and triglycerides (P < .001).

<sup>g</sup>Significant differences at baseline for SBP, P = .003.

# Using Stata to Create 95% CI for a Mean

- The “cii” command
  - Syntax “cii  $n$   $\bar{x}$   $s$ ”
  - For example 1:  
 $\bar{x} = 123.4$  mm Hg;  $s = 13.7$  mmHg;  $n = 100$

```
. cii 100 123.4 13
```

Variable	Obs	Mean	Std. Err.	[95% Conf. Interval]
	100	123.4	1.3	120.8205 125.9795