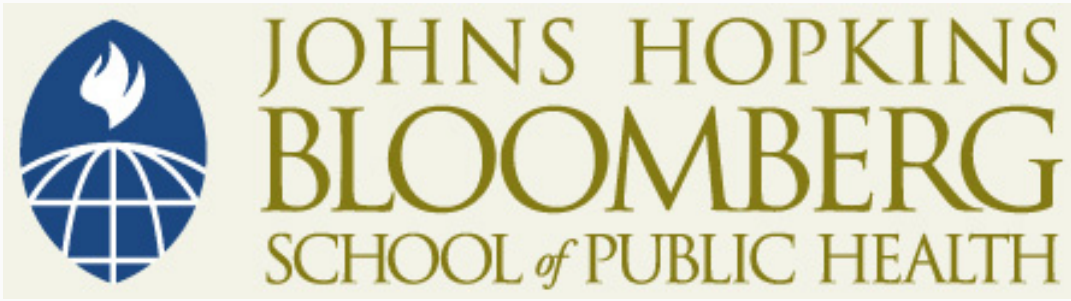

JOHNS HOPKINS
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Section C

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 μ
- Interval given by $\bar{x} \pm 2SE(\bar{x}) : \bar{x} \pm 2^* \frac{\sigma}{\sqrt{n}}$
- Problem: we don't know σ either
  - Can estimate with s, such that our estimated SE is
  - $\hat{SE}(\bar{x}) = \frac{s}{\sqrt{n}}$
- Estimated 95% CI for μ 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
  - $$S\hat{E}(\bar{x}) \frac{13}{\sqrt{100}} = 1.3 \text{ mmHg}$$
- So a 95% CI for the true mean BP of all Hopkins Students:
  - 123.4 ± 2×1.3 → **123.4** ± 2.6
  - → (120.8 mmHg, 126.0 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[1]
  - "**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."

Notes: [1] Howard, B., et al. *(2008)*. Effect of lower targets for blood pressure and LDL cholesterol on atherosclerosis in diabetes: The SANDS Randomized Trial. *Journal of the American Medical Association 299, no. 14*.

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[a]

	Mean (95% Confidence Interval)							
	Baseline		36 mo[b]		Change at 36 mo			*P* Value for Difference
	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[c]	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[d]	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)[e]	0.9 (9)[e]	1.6 (–0.4 to 3.6)[e]	.12[e]
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)[f]	<.001
SBP, mm Hg	128 (126 to 130)[g]	133 (131 to 135)[g]	117 (115 to 118)	129 (128 to 130)	–11 (–13 to –9)	–3 (–5 to –1)	8 (6 to 12)[f]	<.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)[f]	<.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)[f]	<.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)[f]	<.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)[f]	<.001
Triglycerides, mg/dL[d]	158 (149 to 167)	168 (159 to 177)	137 (130 to 144)	160 (153 to 168)	–26 (78)[e]	–12 (84)[e]	14 (–3 to 29)[ef]	.06[e]
Hemoglobin A_{1c}	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_{1c} to proportion of total hemoglobin, multiply by 0.01; and for triglycerides to mmol/L, multiply by 0.0113.

[a] Twenty-three baseline variables are compared and presented in Tables 1 and 2.

[b] 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.

[c] BMI is calculated as weight in kilograms divided by height in meters squared.

[d] Geometric mean (95% confidence interval).

[e] *P* value is based on arithmetic mean.

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

[g] Significant differences at baseline for SBP, $P = .003$.

Example 3

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[g] 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 1 3

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