Statistics – Sampling and Margin of Error

- **sampling (in statistics)** → polling a small portion (of a population) which is intended to show what the whole is like
  - random sampling – every possible sample of size n has an equal chance of being selected (IDEAL)
  - biased sampling – some possible samples of size n may have a preference for an specific outcome
  - voluntary sampling – possible samples of size n choose whether or not they will participate
  - convenient sampling – most possible samples of size n are selected because they're easiest to reach

Example 1: Random samples are ideal. Determine if each method produces a true random sample.

a.) asking every tenth person coming out of a health club how many times a week they exercise to determine how often people in the city exercise not random (biased/convenient)

b.) surveying people going into an Italian restaurant to find out people's favorite type of food not random (biased)

c.) the government sending a tax survey to everyone whose social security number ends in a particular digit random – SSN are random #'s

d.) surveying students in a honors chemistry classes to determine the average time students in your school study each week not random (biased/voluntary)

e.) putting names of all seniors in a hat, then drawing names from the hat to select a sample of seniors random – all seniors have same chance of being selected

- **margin of (sampling) error (ME)** → represents a limit on the difference between how a sample responds and how the total population would respond

Margin of Error (ME) "Formula" → If the percent of people in a sampling respond in a certain way is p and the size of the sample n, then 95% of the time, the percent of the population responding in that same way will be between p−ME and p+ME, where $ME = 2\sqrt{\frac{p(1-p)}{n}}$

Example 2: Find the margin of error (ME) where round it to the nearest percent. (whole #)

a.) p = 72% and n = 100 (p = .72, ME = ?)
$ME = 2\sqrt{\frac{.72(1-.72)}{100}}$
$ME = .09 \Rightarrow$ **ME = 9%**

b.) p = 31% and n = 500 (p = .31, ME = ?)
$ME = 2\sqrt{\frac{.31(1-.31)}{500}}$
$ME = .04 \Rightarrow$ **ME = 4%**

c.) In a survey of 1000 (n = 1000) randomly selected adults, 37% answered "yes" to a particular question. (p = .37, ME = ?)
$ME = 2\sqrt{\frac{.37(1-.37)}{1000}}$
$ME = .03 \Rightarrow$ **ME = 3%**

d.) In a survey of 520 (n = 520) randomly-selected high school students, 68% of those surveyed stated that they were involved in extracurricular activities. (p = .68, ME = ?)
$ME = 2\sqrt{\frac{.68(1-.68)}{520}}$
$ME = .04 \Rightarrow$ **ME = 4%**

Example 3: Find the number of people surveyed in each situation.

a.) p = 67% and ME = 2% $n = ?$

$p = .67$, $ME = .02$

$$\frac{.02}{2} = \frac{2\sqrt{\frac{.67(1-.67)}{n}}}{2}$$

$$(.01)^2 = \left(\sqrt{\frac{.2211}{n}}\right)^2$$

$$1 \times 10^{-4} = \frac{.2211}{n}$$

$$\frac{(1 \times 10^{-4})n}{1 \times 10^{-4}} = \frac{.2211}{1 \times 10^{-4}}$$

$n = 2211$ ppl surveyed

b.) In a recent Gallup Poll, 25% of the people surveyed said they had smoked cigarettes in the past week. The margin of error was 3%

$p = .25$, $ME = .03$, $n = ?$

$$\frac{.03}{2} = \frac{2\sqrt{\frac{.25(1-.25)}{n}}}{2}$$

$$(.015)^2 = \left(\sqrt{\frac{.1875}{n}}\right)^2$$

$$2.25 \times 10^{-4} = \frac{.1875}{n}$$

$$\frac{(2.25 \times 10^{-4})n}{2.25 \times 10^{-4}} = \frac{.1875}{2.25 \times 10^{-4}}$$

$n = 833$ ppl surveyed

Example 4: Find the percent of people surveyed in each situation.

a.) n = 1000 and ME = 3%. $p = ?$

$$\frac{.03}{2} = \frac{2\sqrt{\frac{p(1-p)}{1000}}}{2}$$

$$(.015)^2 = \left(\sqrt{\frac{p-p^2}{1000}}\right)^2$$

$$1000 \times 2.25 \times 10^{-4} = \frac{p-p^2}{1000} \times 1000$$

$$.225 = p - p^2$$

$+p^2 \quad -p \quad +p^2$

$$p^2 - p + .225 = 0 \rightarrow Y_1$$

$0 = \rightarrow Y_2$

Find intersection:

left side = .34 → 34%.

right side = .66 → 66%.

34% or 66% of people surveyed said "yes".

b.) According to a survey in American Demographics, 283 Americans age 12 or older said they listen to the radio every day. The survey had a margin of error of 5%. $n = 283$, $p = ?$, $.05$

$$\frac{.05}{2} = \frac{2\sqrt{\frac{p(1-p)}{283}}}{2}$$

$$(.025)^2 = \left(\sqrt{\frac{p-p^2}{283}}\right)^2$$

$$283 \times 6.25 \times 10^{-4} = \frac{p-p^2}{283} \times 283$$

$$.176875 = p - p^2$$

$Y_1 \rightarrow p^2 - p + .176875$

$Y_2 \rightarrow 0$

Find intersection:

left side = .23 → 23%.

right side = .77 → 77%.

23% or 77% of people surveyed said "yes"