

## 20.21: Misusing SEM

### Learning Objectives

- Misusing Standard Error of the Mean (*SEM*)

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### Overview

Authors of published research articles often erroneously use the standard error of the mean to describe the variability of their study sample. Nagele demonstrated this misuse of the standard error of the mean as a descriptive statistic by manually searching four leading anesthesia journals in 2001.

Here are quotes on key points from Nagele's article and our notes:

"Descriptive statistics aim to describe a given study sample without regard to the entire population."

"If normally distributed, the study sample can be described entirely by two parameters: the mean and the standard deviation (*SD*). However, a study sample variable is never exactly normally distributed. When a variable is close to normally distributed, the mean and median are quite similar. Therefore, the mean and *SD* would be sufficient.

"The *SD* represents the variability within the sample." It tells us about "the distribution of individual data points around the mean." The latter statement, however, is a generalization since the *SD* cannot tell us exactly where each data point lies relative to the mean.

"[I]nferential statistics generalize about a population on the basis of data from a sample of this population."

The standard error of the mean (*SEM*) "is used in inferential statistics to give an estimate of how the mean of the sample is related to the mean of the underlying population." It "informs us how precise our estimate of the [population] mean is."

Thus, "the *SEM* estimates the precision and uncertainty [with which] the study sample represents the underlying population."

The standard error of the mean is calculated by dividing the sample standard deviation by the square root of the sample size ( $SEM = SD/\sqrt{n}$ ).

"[T]he *SEM* is always smaller than the *SD*." However, this is only true as long as the sample size is greater than 1.

"In general, the use of the *SEM* should be limited to inferential statistics [for which] the author explicitly wants to inform the reader about the precision of the study, and how well the sample truly represents the entire population [of interest]." A sample never truly represents the population.

### Questions to Answer

How prevalent is the inappropriate use of the *SEM* in describing the variability of the study sample in research publications? What is the proper use of the *SEM*?

### Design Issues

The author focused on four leading anesthesia journals in his field of expertise. The misapplication of the *SEM* in descriptive statistics can be found in professional journals of many, if not all, fields of research.

### Descriptions of Variables

Table 20.21.1: Description of Variables

Variable	Description

Incorrect use of SEM; total	Total frequency of misuse of SEM; expressed as number of articles and percent
Laboratory studies using SEM incorrectly	A subset of the above variable; expressed as number of articles and percent
Correct use of SD	Frequency of correct use of standard deviation; expressed as number of articles and percent

## Data Files

Sem.xls

## Links

Nagele article

## References

- Nagele, P. (2003). Misuse of standard error of the mean (SEM) when reporting variability of a sample. A critical evaluation of four anaesthesia journals. *British Journal of Anaesthesia*, 90, 514-516.
- Hassani, H., Ghodsi, M., Howell, G. (2010). A note on standard deviation and standard error. *Teaching Mathematics and Its Applications*, 29, 108-112.
- Altman, D. G., Bland, J. M. (2005). Standard deviations and standard errors. *BMJ*, 331, 903.

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