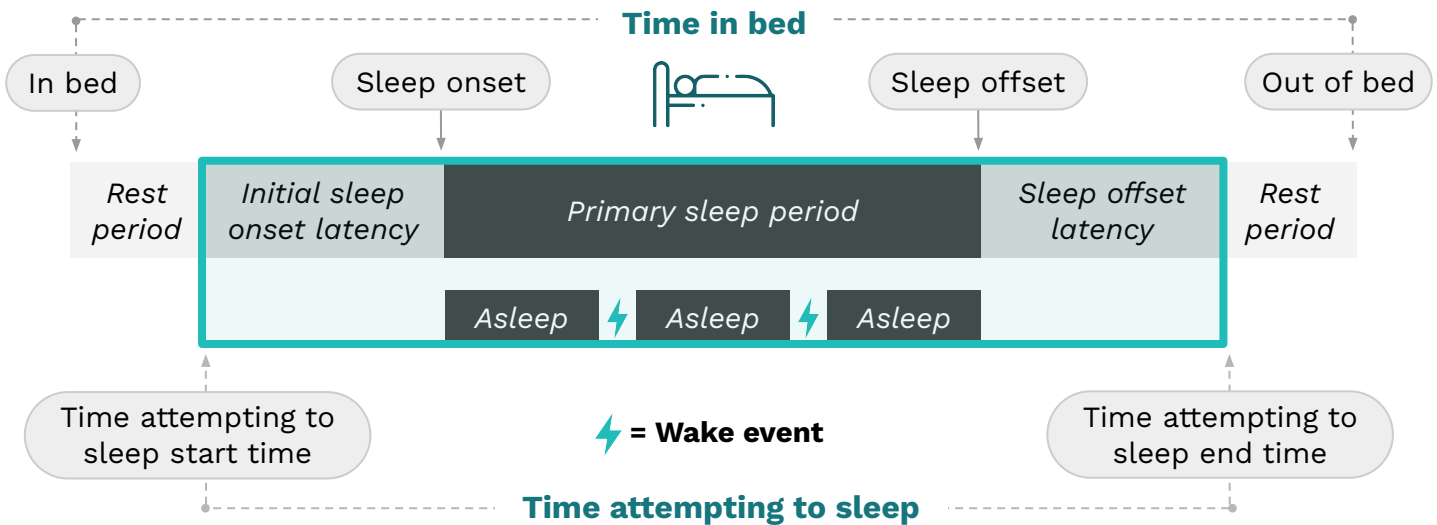


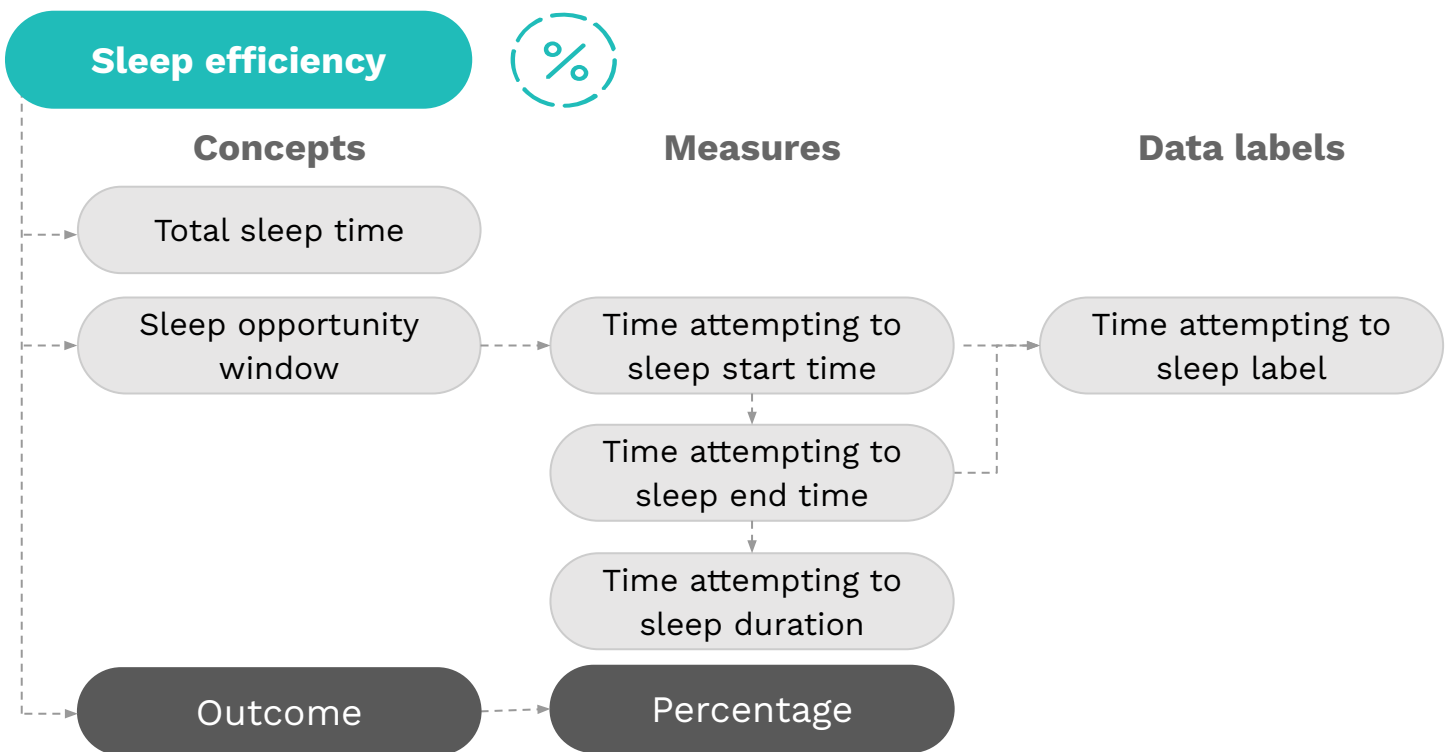
Core Digital Measure of Sleep: Sleep efficiency (Percentage)

Type: Percentage

Definition: The proportion of time spent sleeping when the individual intends to sleep



$$\text{Sleep efficiency} = \frac{\text{Total sleep time}}{\text{Time attempting to sleep duration}} \times 100$$



Measure considerations

Importance: Sleep efficiency is a simple metric displaying the percentage of time the individual spent asleep between the time attempting to sleep start and end times.

Measure derivation: The total sleep time divided by the time attempting to sleep duration. Multiplying this value by 100 expresses sleep efficiency as a percentage.

Optional deviations: The most appropriate selection for the sleep efficiency denominator is still a point of active discussion in the field of sleep research.¹ Where time attempting to sleep is not collected, the primary sleep period or the total time spent in bed can be used as a proxy. This deviation must be made clear in the specifications.

Time attempting to sleep label

Type: Status label

Description

Epochs covering the primary period of time where the individual intends to sleep.

Label definition

A label for each epoch between the point at which the individual intends to start sleeping to the point which the individual intends to stop sleeping.

The Intention to start and end sleep could be provided by user input or detected by an algorithm. The parameters or algorithms for detecting the individual's intention to sleep should be clearly defined or referenced.

Why is this important?

The inclusion of intention is difficult for measurement, as it is non-observable and must be inferred or reported. However, intention is important for distinguishing between epochs that record quiet restfulness (e.g., lying in bed reading) from the active process of trying to achieve sleep. Distinguishing between the two will lead to more sensitive measurement of sleep parameters.

Derived variables

Time attempting to sleep start time

Variable definition

The **timestamp** of the first epoch with the time attempting to sleep label.

Time attempting to sleep end time

Variable definition

The **timestamp** of the final epoch with the time attempting to sleep label.

Time attempting to sleep duration

Definition: A **time duration (seconds)** calculated as the difference between the Time Attempting to Sleep Start and End Times.

References

1. Reed, D. L., & Sacco, W. P. (2016). Measuring sleep efficiency: what should the denominator be?. *Journal of clinical sleep medicine*, 12(2), 263-266.

