How Variable is Sleep?

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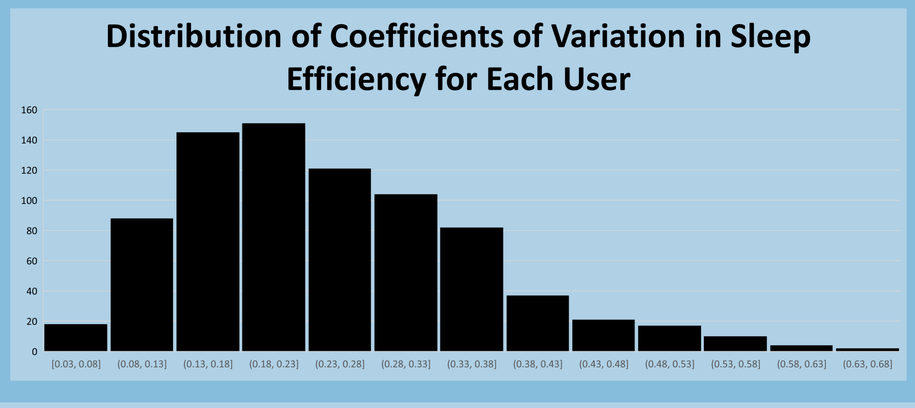
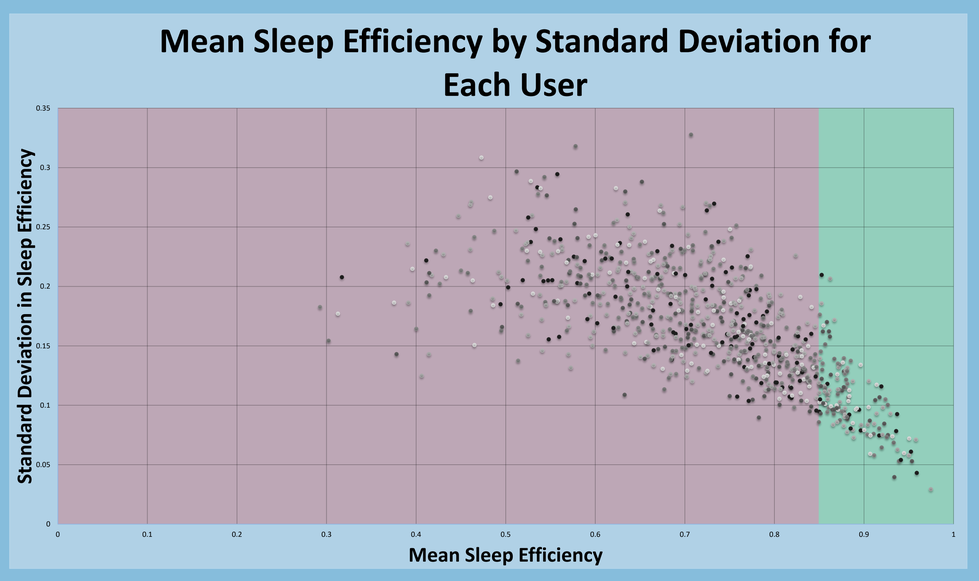
INTRODUCTION

Sleep patterns are often described in terms of the average over a 1-2 week period of assessment with either self-report (e.g. sleep diary) or objective (e.g. actigraph) data. In recent years, there has been greater interest in the variability in sleep over time, but again variability has mainly been studied using short-term "snippets" of data spread out over a short timeframe that is not suitable for identifying more long-term patterns. There is a need for longer-term monitoring in order to better understand the extent to which sleep patterns are stable/unstable in individuals over time. One approach is to utilize "smart" mattress sensor technology that can assess sleep unobtrusively over long periods of time, with little-to-no burden on the subject. The present study examined variability in sleep over periods up to over a year using sleep efficiency assessed with mattress sensors as a global index of sleep quality.

METHODS

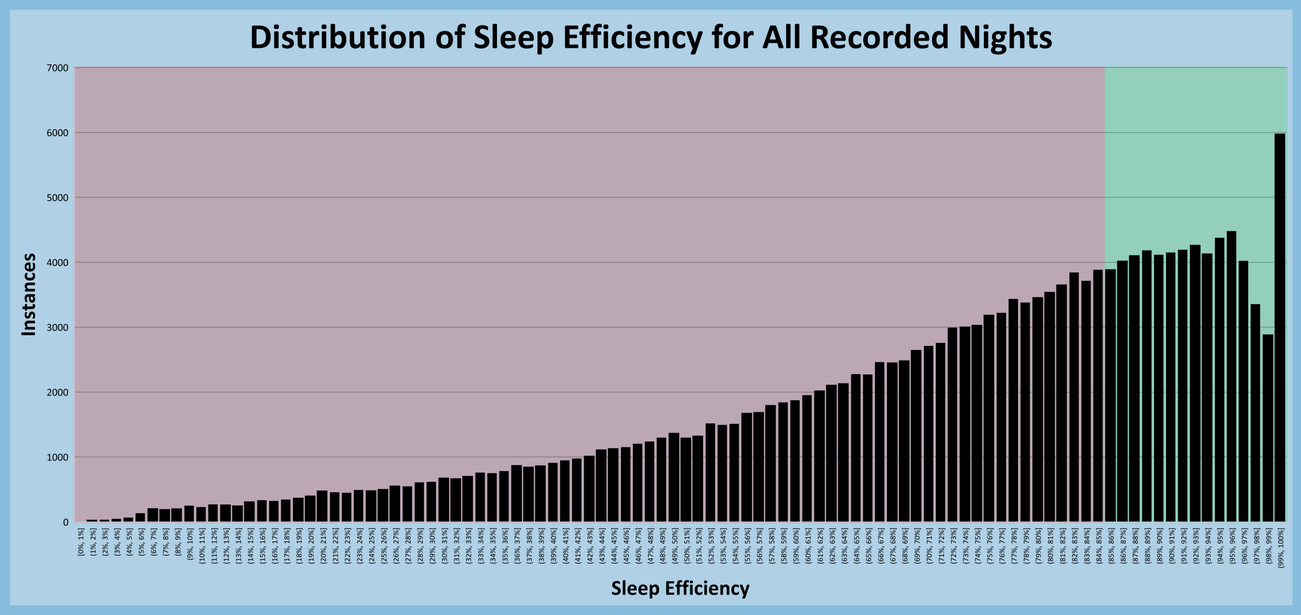
Data were from users of the Eight Sleep mattress, which collects and integrates data from multiple sensors to estimate sleep/wake patterns. Nights were categorized as "good" and "bad" nights using a cutoff of 85%. Lengths of strings of good nights and bad nights were calculated. Descriptive statistics were computed to describe both individual means as well as variability across nights. To account for the inability to distinguish between time in bed and time when the mattress user was trying to fall asleep, sleep efficiency after sleep onset was also calculated. Pearson's correlations were conducted between means and standard deviations of individuals' sleep efficiencies.





RESULTS

The sample consisted of 801 "smart" mattress users who had valid data from 180 to 464 nights, a total of 180,044 nights. 54.93% of the sample was male and 45.07% was female, with a mean (SD) age of 40.36 (12.07). The mean sleep efficiency across individuals was 72.41%, with a mean standard deviation of 16.65%. 35.34% of nights were classified as good nights, and 64.66% were poor. The mean (SD) coefficient of variation was .25 (0.11), with a range of 0.03 to 0.65, indicating a wide range of variability. When strings of nights were examined, the mean (SD) length of a string of nights (good or bad) was 3.35 (6.71) nights, with the mean (SD) length of a string of good nights being 2.38 (3.55) and the mean (SD) length of a string of bad nights being 4.33 (8.68). The mean sleep efficiency with sleep onset removed was 78.67%, with 49.14% of the nights being classified as good nights and 50.86% of the nights being classified as bad nights. There was a significant correlation between individuals' mean and standard deviation in sleep efficiency (r = -.69, p < .01), such that higher mean sleep efficiency was associated with less variability.



CONCLUSION

When examined over longer periods of time, there is considerable variability in sleep efficiency both within and between individuals. Individuals with poorer sleep overall also tend to have more variable sleep over time. "Smart" mattress pads are a pragmatic tool that can be used to gather large amounts of continuous, longitudinal sleep data. Limitations of these data include the inability to distinguish between time getting into bed and time the user is trying to fall asleep.

A larger than expected percentage of the recorded nights were below 85% sleep efficiency, and thus considered bad nights. This may be accounted for by the fact that sleep efficiency was calculated based on time in bed, which includes time spent in wakeful activities and not just when trying to sleep. There is also the potential for a sampling bias, as individuals may be more likely to purchase a smart mattress if they already have difficulty sleeping, or some combination of these two factors.