

The Parable of Parabola: What the U-Shaped Curve Can and Cannot Tell Us about Sleep

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EITHER TOO MUCH OR TOO LITTLE OF A GOOD THING IS BAD...OR SO THE STORY GOES.

SLEEP HAS RECENTLY PUBLISHED TWO PAPERS ON SLEEP DURATION-MORTALITY ASSOCIATIONS, BASED ON WELL-ESTABLISHED LARGE COHORTS—IN FINLAND, The Finnish Twin Cohort¹ and in Great Britain, The Whitehall II Cohort²—both endowed with rich covariate data. Associations between short and long sleep durations and mortality were first noted by Hammond in 1964 in the American Cancer Society I study,³ and they later achieved notoriety when presented by Kripke et al in 1979⁴ (see reference 5 for a review of studies with similar findings.) Although the number and specificity of publications to further explore these controversial findings rapidly increased, most studies relied on the association of sleep duration measured at a single time point with followed-up mortality. Noteworthy in the Hublin et al¹ and Ferrie et al² studies is that participants were queried about their sleep durations at two different time points separated by intervals of 5 to 6 years, and mortality was assessed 22 and 12 years, respectively, subsequent to the second measurement. This feature effectively eliminates the possibility that the tails of the habitual sleep distribution (short or long sleep) were reflecting terminal illnesses or death-imminent processes, even in their most subtle stages. Only one prior study attempted to account for this limitation by eliminating deaths shortly after the ascertainment of sleep duration,⁶ but the two-year interval used may not have entirely eliminated this possibility.

The repeated surveys in both Hublin et al¹ and Ferrie et al² demonstrate reliability in the subjects' answers over time, indicating that these were not spurious or "random" estimates of sleep duration. Furthermore, the repeated measures allowed investigation of change in sleep duration over time. Particularly interesting in Ferrie et al was that increases in sleep duration over time (from less than 5 to 7 hours or more) in some individuals was associated

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with decreased mortality risk. This finding provides cautious optimism for intervention and risk attenuation, akin to the mortality reductions seen following smoking cessation.

Apart from such quasi-experimental inferences, a very fundamental question remains unanswered: *What exactly does it mean when an individual reports that he or she does not sleep 7 to 8 hours a night?* Although it is tempting to assume that the observed mortality associations reflect the effects of varying sleep duration, the validity of self-reported sleep duration remains elusive. Studies with both objective and subjective sleep duration data have shed little light on this question; objective data from a single night's sleep do not appear to be a good measure of "usual sleep duration." In the Sleep Heart Health Study,⁷ self-reported sleep duration estimates were about an hour longer than polysomnographic measurements. Repeated measures over several nights, with less burdensome methods such as actigraphy, should increase precision and thus might better characterize sleep duration. But recent actigraphic data in the population-based CARDIA study suggest larger night-to-night variation, compared with year-to-year intrasubject variation in sleep duration,⁸ and self-reported estimates of sleep duration were still, on average, an hour longer than those estimated by actigraphy.⁹ The CARDIA data also showed sleep duration varied by weekdays versus weekends,⁹ a factor which would also add error variance to the estimates of sleep duration.

So what *are* people telling us when they report sleeping 6 or less or 9 or more hours a night? Self-reported sleep duration is surely a complex proxy for many factors, and those factors may not be equivalent on the long and short tails of the distribution. Increasingly, the answer to this question may be aided by social and behavioral science. For example, demographics may be crucial in determining how much time an individual devotes to quality sleep.¹⁰ Apart from Hublin et al¹ and Ferrie et al,² several other recent studies suggest that socioeconomic status (SES) plays a major role in sleep durations, with more hours at work associated with less time devoted to sleep;¹¹ some, but not all, of these effects may be accounted for by race.^{9,12} Lower income was associated with both longer and shorter sleep durations in the Nurses Health Study.¹³ Similarly, Ferrie et al² note SES factors operating in their UK population. However, in spite of SES and related risk factors being likely markers of long and short sleep as well as being predictors of mortality, these factors did not explain away the U-shaped curve in either study, suggesting that the sleep durations seem to prognosticate in their own right.

How about behavioral factors? Experimental psychology teaches us that reporting bias, demand characteristics, and social desirability all can impact how an individual responds to a survey question. It also is apparent that sleep duration may be partially disassociated from experienced sleep quality, yielding many duration-quality categories. For example, on the short sleep side,

time devoted to work at the expense of sleep may be associated with good quality sleep, just short sleep. Alternatively, short sleep may result from disturbed sleep due to chronic pain. Interactions also operate on the long tail of the distribution, to the extent that up to 10% of individuals reporting sleep of ≥ 9 hours report poor sleep.^{14,15} To more specifically examine quality versus duration, Hublin et al¹ tested sleep quality as an independent predictor of mortality, and examined interactions of sleep duration and quality as well. Surprisingly, although some associations between sleep quality and mortality were reported, these were not nearly as compelling as those associated with short and long sleep duration.

Mental health factors may be other correlates of long and short sleep durations.^{6,13} When an individual's response to a single sleep duration question was compared to that same individual's responses derived from daily call-ins over a subsequent 2-week time period, discrepancies were substantial.¹⁶ Some individuals reported longer duration compared with their initial response, whereas others reported shorter duration. Somewhat surprising was that the greater the discrepancy (regardless of direction), the more likely that individual was to report depressive symptoms.¹⁶ Such findings imply that individuals may report sleep duration with all kinds of unexamined behavioral biases. In essence, "how many hours of sleep do you get at night" and the rejoinder of "7 to 8" might be the ersatz equivalent of uttering "how ya doin'" and hearing the mundane banality of a "good" or "OK" response. Anything falling outside that category puts the questioner on notice for something, but we are just not sure on notice for what.

In summary, with nearly 50 years of research data behind us we still do not fully understand what it means when someone answers a question about sleep duration with a response that falls outside the bell of the curve. The parable of parabola persists: stay tuned for further developments as this, the most famous survey item in the history of modern sleep research, continues to beg an answer.

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