Sleep of Aging Women and Men: Back to Basics


and

Latta F; Leproult R; Tasali E et al. Sex differences in delta and alpha EEG activities in healthy older adults. SLEEP 2005;28(12):1525-1534.

Derk-Jan Dijk, PhD

Surrey Sleep Research Centre, University of Surrey, Guildford, United Kingdom

“CONSIDERING THE PAUCITY OF KNOWLEDGE ABOUT SLEEP IN WOMEN, IT IS CONCERNING THAT WE FOUND SUCH A LOW PROPORTION OF PAPERS IN THIS area, and no indication of increased research about issues of sleep in women.” This was the conclusion derived from a literature review by Driver and colleagues at the end of the last century.1 The first 5 years of this century have seen an impressive increase in the interest in sex/gender differences in sleep regulation. In the December issue of the SLEEP, 2 new research papers,2,3 both written by Dr. Latta and her colleagues from Dr. Van Cauter’s laboratory at the University of Chicago, focus on some of the differences in the sleep of older women and men. The papers demonstrate how a comparison of sleep of women and men leads to basic questions about the most commonly used tools to quantify sleep, as well as the interactions between the endocrine and sleep-regulatory system.

The Issues I: Slow-Wave Sleep, Sleep Depth, and Objective Versus Subjective Sleep Quality

Subjective and objective sleep quality both decline with aging. Survey studies show that women report more sleep complaints than men in nearly all age groups, including the middle-aged and the elderly.4,5 This impressive gender difference in the complaints about sleep is not reflected in some of the commonly used physiologic markers of sleep quality. From a sleep physiologic perspective, it is the quality of sleep in men and sleep efficiency and slow-wave sleep (SWS) in particular that deteriorates most with aging.6 SWS, which is considered to be “deep” sleep, is defined on the basis of the amplitude and frequency of the electroencephalogram during non-rapid eye movement (NREM) sleep. Quantitative analysis of the electroencephalogram (EEG) during sleep has revealed gender differences in the power spectrum. These gender differences are not limited to the slow-wave range, NREM sleep, or older people. In fact, in women, EEG power-density values are higher over a wide frequency range in both NREM and rapid eye movement (REM) sleep and over a wide age range. This may suggest that the observed gender difference in slow-wave (or delta) activity and visually scored SWS are either a consequence of gender differences in the amplitude of the EEG or may reflect gender differences in (SWS) sleep regulation (see reference 2).

In the current papers, an attempt is made to distinguish between these 2 interpretations. The sleep EEG in a small sample of healthy postmenopausal women and age-matched men is quantified during a baseline sleep episode and a sleep episode during which sleep was disrupted by frequent (every 20-minute) blood sampling. The latter approach addresses the question of whether the sleep of women is more susceptible to disruption, despite the better preserved SWS/delta activity. What do the data show?

Visually scored SWS was not different between the sexes, but the more-sensitive spectral analysis of the EEG confirmed the impressive gender difference in delta activity. In accordance with previous reports, the higher delta activity in women was observed in both NREM and REM sleep. If these higher values of delta activity imply deeper sleep, independent of gender, then women are to be expected to be less affected by the blood-sampling procedure than men. The opposite was observed, both for classical sleep continuity measures as well as delta activity: in women, these variables appeared to be more affected by the blood sampling than in men. Unfortunately, the manuscript does not provide information on the impact on subjective sleep quality of sleep, nor does it inform us about the association between delta activity and susceptibility to disruption within each gender. Nevertheless, the data indicate that, despite the higher delta activity, sleep of women is more easily disrupted.

How to resolve this paradox of 2 measures of sleep depth? The authors propose that rather than using the absolute delta-activity values, which are directly related to the amplitude of the EEG, delta activity in NREM sleep should be expressed relative to total power or to delta activity in REM sleep. It is implied that these normalization procedures better quantify the sleep regulation-related aspect (homeostatic or sleep depth) of delta activity. After normalization relative to the EEG in REM sleep, women have lower values of delta activity during NREM sleep than men, and the paradox disappears.

Are we satisfied that this is a better way to quantify the sleep EEG, providing a more accurate assessment of the sleep homeostasis in men and women? This interesting approach reminds us that

Disclosure Statement
Dr. Dijk has received research support from H. Lundbeck A/S; and is a consultant or advisor for Philips Lighting, H. Lundbeck A/S, Cephalon Inc., Merck Inc., and Sanofi-Aventis.

Address correspondence to: Derk-Jan Dijk, PhD, Surrey Sleep Research Centre, University of Surrey, Guildford GU2 7XP UK; E-mail: d.j.dijk@surrey.ac.uk

SLEEP, Vol. 29, No. 1, 2006

*Some authors make a distinction between gender and sex differences such that sex differences refer to biological differences and gender differences to differences created by the sex-dependent lifetime experience/societal influences on physiology and behavior. In this editorial we will use the word gender to refer to both aspects.
the sleep EEG is the basis of the quantification of the SWS process, whether we use visual scoring or spectral analysis. It does not, however, provide us with a new insight into the nature of the gender differences in the sleep EEG signal or sleep regulation, nor does it resolve the objective versus subjective discrepancy. This discrepancy is obscured by the normalization procedure, and the gender differences in the NREM and REM EEG remain unresolved.

The authors report other, more subtle, gender differences in the time course of delta activity over consecutive REM episodes, as well as a gender-dependent association between delta activity in NREM sleep and REM sleep and some changes in alpha activity. These interesting data may be interpreted as gender differences in the sleep-dependent regulation of the EEG, but no conclusive evidence that the homeostatic aspect of NREM regulation differs in either direction between the genders can be derived from the current analyses. The homeostatic aspect of sleep regulation is best quantified by dose-response studies of sleep loss and recovery sleep, and these approaches may need to be applied to better understand the gender differences in SWS, the sleep EEG, subjective sleep quality, and basic aspects of sleep regulation.

The Issues II: Gender Differences in the Sleep-Dependent Release of Growth Hormone and Prolactin

In the second paper, data collected in the same subject population and experiment were analyzed to address another basic aspect of sleep regulation in the context of gender differences: growth hormone and prolactin release during sleep and wakefulness. Growth hormone and prolactin release are both considered to be primarily sleep dependent, with the primary surge of growth hormone associated with SWS. Previously, the age-related decline in SWS was reported to parallel the decline in growth hormone, and, when the effects of age were controlled for, a correlation between SWS and growth hormone persisted, at least in a sample of 149 men aged 16 to 83 years.

The most striking result derived from the 24-hour profiles of these hormones as reported in the present paper is the magnitude of the sleep-independent release of both hormones in older men and women. For example, it is reported that, in women, only 23.7% of the 24-hour growth hormone secretion occurs during sleep. It remains unclear whether this sleep-independent release is related to the age of the volunteers, or to the relative immobility during wakefulness, or to age-related sleep deprivation.

Several gender differences in growth hormone and prolactin release and their association with sleep stages and delta activity are reported. Growth hormone release during sleep is lower in women than in men, despite the higher absolute delta-activity values. A positive association between growth hormone release during sleep and delta activity is only present in men. Furthermore, presleep growth hormone release is a negative predictor of sleep maintenance in women but not in men. The interpretation of these data becomes complex when we consider that sleep maintenance and delta activity are more disrupted by blood sampling in women than in men. This could imply that some of the observed gender differences in the association between hormones and sleep are a consequence of the interaction of gender and the blood-sampling methodology. This methodologic conundrum should, however, not distract from the findings, which demonstrate how little we know about basic sleep physiology outside the group of healthy young and primarily male volunteers.

Early studies published in this journal indicated that gender differences in SWS can be observed in electrocorticograms recorded in cats. More recently, interaction between clock genes and gender differences in rest of drosophila have been reported. Rutger Wever discovered that, when studied in the absence of social constraints and under synchronized free-running conditions, the period of circadian rhythms is shorter in women than in men. Furthermore, under these conditions, women sleep approximately 1 hour, 21 minutes longer than men. These impressive gender differences in very basic aspects of sleep regulation and the recently reported interaction between these gender differences and development, aging and sleep deprivation; daytime sleepiness and insomnia; alcohol, sleepiness, and driving performance, as well as chronotype, demonstrate that inclusion of men and women of all ages is a powerful tool in the study of sleep in health and disease.

REFERENCES